

**SAMPLING & ANALYSIS PLAN
FOR THE
HAMM CREEK RESTORATION PROJECT**

**DUWAMISH TURNING BASIN
SEATTLE, WASHINGTON**

April 28, 1997

Prepared by:

**David Fox
Dredged Material Management Office
Seattle District
Corps of Engineers**

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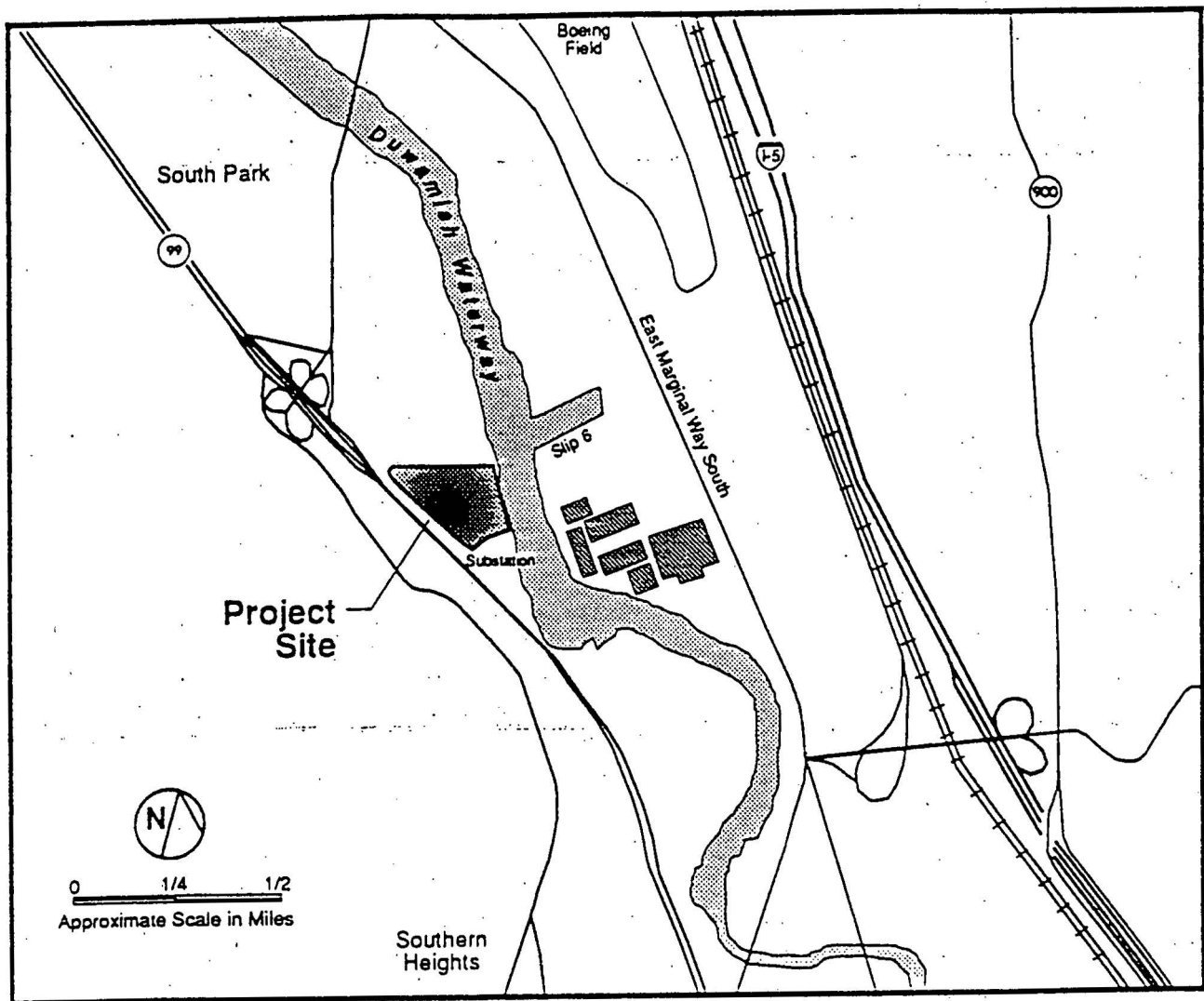
1.0 PROJECT DESCRIPTION, SITE HISTORY AND ASSESSMENT

1.1 Project Description. Hamm Creek will be realigned and 7 acres of a 22-acre piece of land adjacent to the Seattle City Light substation (see Figure 1) will be converted into a combined saltwater/freshwater wetland. This project is part of the Corps of Engineers Restoration Program and will be accomplished under Section 1135 of the Water Resources Development Act of 1986. Approximately 10,000 cubic yards will be excavated in creating meanders in Hamm Creek along West Marginal Way. This material will not be characterized for PSDDA disposal. An additional 80,000 cubic yards will be dredged in providing a new outlet for the creek to the Duwamish River, creating a saltwater marsh in the riverside area and excavating upland for a freshwater wetland. This material is proposed for open-water disposal at the Elliott Bay site or beneficial use and will therefore be characterized under PSDDA and SMS guidelines.

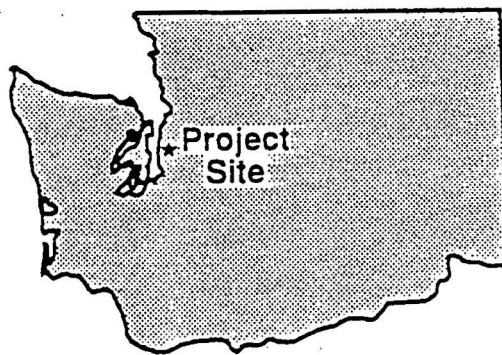
The PSDDA Evaluation Procedures Technical Appendix - Phase I (PSDDA, 1988 - page I-12) allows excavated material, that would otherwise not be allowed for open-water disposal, to be considered dredged material if an ecological benefit can be shown at the dredging site. This project has clear ecological benefit at the dredging site and therefore meets this criterion.

1.2 Site History. The Duwamish estuary was originally mudflat. Most of the area was subsequently filled and developed. A portion of the Seattle City Light property was filled and developed for use as a substation location. The remaining portion, upon which the proposed habitat restoration project will be located, was never developed for industrial or commercial purposes. It was however used as a dredged material stockpiling area. Following is a chronological listing of maps and dredged material placement events involving the site:

- Condition Survey - October 22, 1928 - U.S. Army Corps of Engineers. See Figure A1 in Appendix A. This map shows the Seattle City Light area platted but undeveloped. It is unknown whether the shoreline had been altered prior to this time, but the shoreline in this map was used as a baseline to show alterations at later times.
- Condition Survey - April 23, 1953 - U.S. Army Corps of Engineers. See Figure A2 in Appendix A. Development north of the site has begun (City Packing Company). While no records were found regarding fill on the site between 1928 and 1953, it appears that the shoreline has been straightened and a bulkhead has been constructed along the Duwamish River. If this map represents the actual configuration of the river in 1953, then it is likely that some fill has occurred in the area. There is no indication that Seattle City Light owned the property at this time.
- 1954 - U.S. Army Corps of Engineers dredging records indicate that a dike was constructed and 220,000 cubic yards of dredged material were placed on site as fill for construction of the Seattle City Light (City of Seattle Department of Lighting) substation. The disposal area was bounded by Ham and Schmitz Roads and W. Marginal Way, which encompasses the entire Seattle City Light property.
- Condition Survey - April 4, 1957 - U.S. Army Corps of Engineers. See Figure A3 in Appendix A. The bulkhead configuration has changed, with only that portion of the Seattle City Light property used for the substation now bulkheaded. Some dredging appears to have occurred along the rest of the Seattle City Light shoreline. Dredging records indicate that it was common practice to perform "clean-up" dredging along the shoreline of material that



Vicinity Map



Washington
State

Project Site
Locator Map

Figure

1

had escaped from the disposal site during dredging operations. A "boundary of fill" is indicated on the map and includes the entire site.

- Condition Survey - April 19, 1960 - U.S. Army Corps of Engineers. See Figure A4 in Appendix A. The shoreline and bulkhead configuration has not changed since 1957. Transmission poles and towers are shown, as is a disposal area in the northern portion of the site. Records indicate that 294,000 cubic yards of dredged material were placed on site in 1960. Disposal area dikes, bulkheads and weirs were built with the cost reimbursed by the Department of Highways, which reused the dredged material for construction along Highway 1 (Pacific Coast Highway).
- 1968 - U.S. Army Corps of Engineers dredging records indicate that 375,000 cubic yards of dredged material were placed on site. The City of Seattle paid for the "extra diking" required and the Urban Renewal Department reused the dredged material for unspecified projects.
- 1971 - U.S. Army Corps of Engineers dredging records indicate that 325,000 cubic yards of dredged material were placed on site in May of 1971. General Construction leased the Seattle City Light property as a disposal area. Dikes were constructed by "cat and can" operation. Due to wet weather the top 4 feet of the dike was completed by dragline after the dredging started. The shoreline permit stated that the dike shall be constructed of pit run gravel or some other suitable material. Dredged material was not allowed to be used for dike construction. Bob Parker, the dredging manager for the Corps of Engineers at the time, indicated that pit run material would not have been used, that site material would have been scraped up and pushed into place to construct the dike.
- Condition Survey - November 21, 1975 - U.S. Army Corps of Engineers. See Figure A5 in Appendix A. The photograph was taken in September 1971, after the 1971 dredged material disposal event. It clearly shows the dredged material rehandling area and the diked perimeter. It appears from the bulldozer scrape marks that, within months of the May dredging event, much of the dredged material had already been rehandled and trucked off site. The shoreline differs from earlier drawings, showing perhaps that some filling had occurred.
- Condition Survey - July 31, 1983 - U.S. Army Corps of Engineers. See Figure A6 in Appendix A. The aerial photograph was taken in July 1980. The copy of the photograph is of poor quality but the site appears to be vegetated. The dike along the Duwamish River is still clearly visible and appears to have changed little since 1971. The shoreline had seen minor modifications since the earlier photograph.
- 1985 - Weston (1990) indicates that dredged material from the Duwamish Yacht Club was placed on site. See Appendix B for details.

1.3 Site Description. The following site description was taken from Weston (1990):

"The property comprises approximately 20 acres of open grassy field. It is bounded to the south by Seattle City Light's Duwamish substation, to the north by the Delta Marine Industries facilities, to the east by the Duwamish Waterway, and to the west by West Marginal Place South, a frontage road of Highway 99...An open ditch runs along the west boundary of the property."

"The majority of the property is nearly level. A rectangular depression, approximately 200 feet on a side, is located in the east-central portion of the lease property. The depression apparently marks the area filled with dredged sediment in 1985. The depression appears to be an infilled impoundment in which dredged sediment was placed and allowed to drain."

"The easternmost portion of the property along the Duwamish Water [sic] contains several exposures of milled lumber debris mixed with sandy and clayey silt fill. The lumber-containing fill appears to be a separate fill unit from the 1968 or 1985 fills, although this is uncertain because the relationship between the fill units along the waterway is obscured by vegetation and recent sedimentation. Several decayed pilings are present along the waterway shoreline."

1.4 Boeing Site Assessment. Boeing conducted a site assessment in 1990 as part of its evaluation of a long-term lease option. The 1968 dredged fill was evaluated for metals and PAHs, while the 1985 dredged fill was evaluated for metals, semi-volatiles and PCBs. Additional soil samples were taken from the fence line along the substation perimeter and analyzed for PCBs and chlorinated pesticides. Groundwater was assessed for volatile organics to determine whether any spills had impacted the site.

Of the soil chemicals analyzed, only cadmium and mercury were detected above the PSDDA SL, with maximum concentrations of 1.3 and 0.51 mg/kg respectively. No organics were detected above PSDDA SLs. However, detection limits in the site assessment were geared toward meeting the Washington Model Toxics Control Act Cleanup Regulations rather than PSDDA testing requirements, therefore a number of detection limits were above the PSDDA SLs. For example, PCBs were not detected in the 1985 dredged fill, but the detection limit for Aroclor-1254 and Aroclor-1260 was 210 ug/kg (SL = 130). The only chemical detected in the groundwater was acetone, a common laboratory contaminant.

Weston (1990) includes the following description of the subsurface stratigraphy:

"The subsurface investigation indicates that the property is underlain by approximately 5 to 10 feet of stratified, heterogeneous fill that, in turn, overlies alluvium of the Duwamish River floodplain. Apart from the man-made levee along the present bank of the Duwamish Waterway, the fill appears to thicken progressively westward across the property. The fill is thinnest (5.5 to 6.2 feet) in the topographic depression in the east portion of the property that apparently coincides with the limits of the 1985 dredge fill."

"Relatively little lithologic or textural difference was noted between the 1968 and 1985 fills. The fill is composed predominantly of crudely layered silty sand and clayey silt. The upper 1 to 4 feet of the fill is typically a loose to medium-dense, moist, brown, silty sand. Dense, black, carbonaceous, fine sand and stiff, black, clayey silt typically occur beneath the surface layer. The black sand and silt often contain abundant wood fragments. In some borings, a saturated, gray, well-graded sand layer 0 to 4 feet thick occurs at or near the base of the fill."

"Fill overlying alluvium was also observed in an eroded exposure along the west bank of the Duwamish Waterway. Very abundant milled lumber debris occurs in a sandy to clayey matrix at low elevations along the bank and may be a separate fill unit from the 1968 and 1985 dredge fill units described here."

"Alluvium underlying the fill consists of approximately 2 to 3 feet of gray, mottled, massive, clayey silt that often contains plant fragments. Below the mottled clayey silt is a 1.5 to 4-foot-thick unit composed of thinly bedded, gray and brown, clayey silt and fine sand. In the three

deepest borings, (i.e., MW-1, MW-2, and MW-3), a minimum of 3 to 7 feet of saturated, gray sand is present at the base of the explorations. The total thickness of this sand unit at the site is not known because it was not fully penetrated by any of the borings. The alluvium is interpreted to be fine-grained bioturbated and stratified overbank deposits and coarser channel sands of the Duwamish River."

See Appendix B for details of the site assessment.

2.0 SAMPLING AND ANALYSIS OBJECTIVES

The sediment characterization program objectives and constraints are summarized below:

- To characterize sediments to be dredged in conformance with PSDDA requirements to enable the PSDDA agencies to provide a suitability determination relative to PSDDA disposal.
- To provide detection limits comparable to SMS standards where practicable in order to allow determination of the acceptability of beneficial use of dredged material.
- To collect, handle and analyze representative sediment core samples characterizing the full dredging prism in accordance with protocols and QA/QC requirements outlined in the PSDDA Evaluation Procedures Technical Appendix (June 1988), the updated procedures documented in Chapter 5 and Appendix A of the PSDDA Phase II Management Plan Report (September, 1989), modifications made through the PSDDA Annual Review Process and procedures presented in PSEP Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound.
- To conduct core sampling, compositing and analyses in a timely manner to meet PSDDA requirements for sample holding times, including those related to possible biological analysis if needed.

3.0 PROJECT TEAM AND RESPONSIBILITIES

The sediment characterization program will include 1) project planning and agency coordination, 2) field sample collection, 3) laboratory preparation and analysis, 4) QA/QC management and 5) final data report. Staffing and responsibilities are outlined below:

Table 1. PSDDA characterization responsibilities

Task/Responsibility	Pat Cagney	David Fox	Lisa Roach	Mark Fugiel	Ormerod/Redmond
Overall project management	✓				
Sampling plan development		✓			
Positioning			✓		
Sediment sampling			✓		
Compositing/subsampling			✓		
Chemical analysis & QA				✓	
Biological analysis & QA					✓
Final Report			✓		

Pat Cagney, U.S. Army Corps of Engineers, Seattle District, Environmental Resources Section
David Fox, U.S. Army Corps of Engineers, Seattle District, Dredged Material Management Office
Lisa Roach, Science Application International Corporation, Bothell
Mark Fugiel, AmTest Laboratories, Seattle
Dayle Ormerod, Parametrix, Kirkland
Michelle Redmond, NW Aquatic Sciences, Newport

4.0 PSDDA SAMPLING AND ANALYSIS REQUIREMENTS

4.1 PSDDA Ranking.

The proposed restoration site is adjacent to the section of the Duwamish River where the rank for the federal navigation project changes from low-moderate to high-ranked. However, the site assessment completed by Boeing in 1990 indicates that the material proposed to be dredged for this project should be ranked low-moderate for PSDDA characterization. The maximum concentrations of the only detected metals, cadmium and mercury, were between SL and (SL+ML)/2, the range associated with a low-moderate rank (EPTA 1988). All detected concentrations of organics were below SLs. Detection limits for undetected organics were generally in the low to low-moderate range, including the detection limits for PCBs.

In addition, dike material appears to have come from onsite. Since the site had never been developed for industrial use and since the Boeing site assessment did not show any chemicals of concern at concentrations above those qualifying for a low-moderate rank, a low-moderate rank was used to determine the sampling and analysis requirements for this project.

4.2 Sampling and Analysis Requirements.

Based on a low-moderate rank, full characterization requirements for this project are outlined below:

Surface Sediments: One core section for every 8,000 cubic yards and
(0 to 4 ft.) one laboratory analysis for each 32,000 cubic yards.

Subsurface Sediments: One core section for every 8,000 cubic yards and
(> 4 ft.) one laboratory analysis for each 48,000 cubic yards.

The estimated total volume of material to be characterized for PSDDA disposal is 80,000 cubic yards. The quantity and related sampling requirements are distributed as follows:

Table 2. PSDDA sampling and testing requirements

Depth Interval	Volume (cu.yds.)	Minimum No. of Core Sections	Number of Analyses
0-4 ft.	32,000	4	1
>4 ft.	48,000	6	1
Total	80,000	10	2

5.0 SAMPLE COLLECTION AND HANDLING PROCEDURES

5.1 Sampling and Compositing Scheme.

Figure 2 shows the existing ground elevations, while Figure 3 shows the design elevations and PSDDA sampling locations. Table 3 includes the existing and design elevations at each sampling location, the total length of each PSDDA bore, and the core section designations at each location. Table 4 shows the corresponding core sections and laboratory composites. The "Z" samples will be taken from the first foot beyond the design depth at stations 2 and 4 and archived for potential future analysis.

Table 3. Sampling station elevations and boring depths

Sampling Station Number	Existing Elevation (MLLW)	Design Elevation (MLLW)	Length of Sediment Bores (including "Z" samples)	Core Section Designations and Depths
1	+23	+4	19	A +23 to +19 B +19 to +15 C +15 to +11 D +11 to +7 E +7 to +4
2	+25	+13	13	A +25 to +21 B +21 to +17 C +17 to +13 Z +13 to +12
3	+21	+11	10	A +21 to +17 B +17 to +13 C +13 to +11
4	+23	+13	11	A +23 to +19 B +19 to +15 C +15 to +13 Z +13 to +12

Table 4. Sample Compositing Plan

DMMU	Core Sections	Volume (CY)
C1	1A/2A/3A/4A	32,000
C2	1BCDE/2BC/3BC/4BC	48,000

Duwamish River

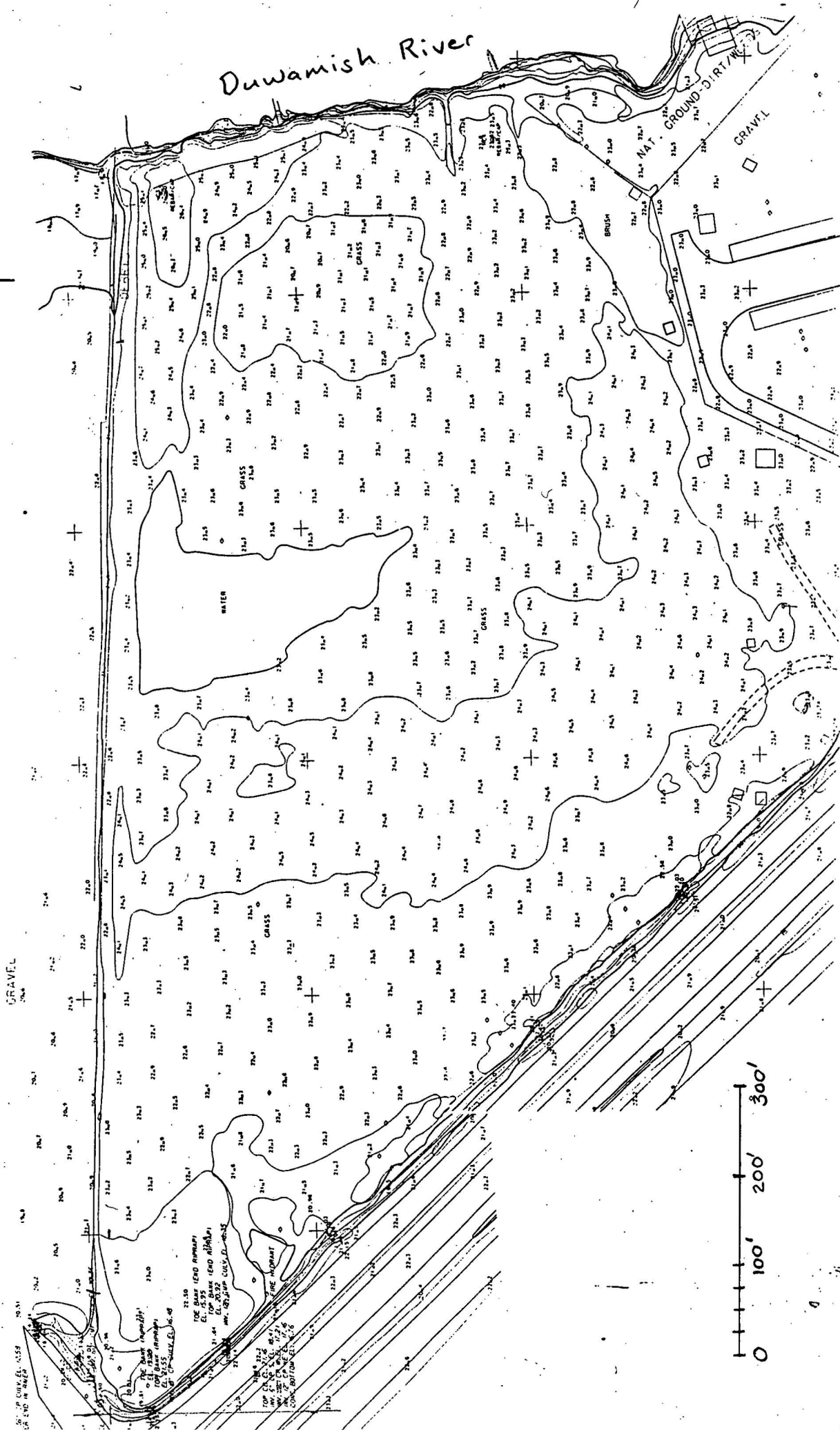


Figure 2



N 192
E 1.63'

SE

Owlansh R.

UPLAND
WETLAND

UPLAND WETLAND

W. Marginal Way

Hamm
Creek

⊗ PSDDA
Sampling
Station



Figure 3

5.2 Field Sampling Schedule. Sampling is planned for May 1997. All sampling will be completed in a single day. Compositing will occur in the field and laboratory samples will be delivered the same day to AmTest.

5.3 Sample Collection Method. Samples will be collected using a truck-mounted, hollow-stem auger drilling rig equipped with a split-spoon sampler. The first sample will be collected from zero to two feet of depth. The auger will then be advanced to the bottom of the sample depth and the next two-foot sample will be taken. These two subsamples will be labeled "A1" and "A2" on the boring logs.

This method of sampling, retrieval and auger advancement at two foot intervals will be utilized until the total sample depth is reached. The recovered subsurface core-segments will be labeled in alphabetical order starting with "B". There will be two cores for each letter, except in those cases where the deepest core is two feet long or less. Compositing will follow the scheme presented in Table 4. The "Z" samples will be taken from stations 2 and 4, consisting of one foot of sediment beyond the design depth at these two stations.

5.4 Field Notes. Field notes will be maintained during sampling and compositing operations. Included in the field notes will be the following:

- Names of the drilling rig operator and person(s) collecting and logging in the samples.
- Weather conditions.
- Elevation of each boring station sampled as measured from mean lower low water (MLLW NAD83). This will be accomplished using a surveyor's level to determine the elevation at the sampling location referenced to an on-site vertical reference.
- Date and time of collection of each sediment split-spoon sample.
- The sample station number as derived from Figure 2 and Table 3, and individual designation numbers assigned for each individual core section.
- Descriptions of core sections.
- Any deviation from the approved sampling plan.

5.5 Positioning. Sampling locations will be surveyed and flagged prior to the actual sampling effort. The flagged stations will be used to position the drill auger during sampling. Elevations will be referenced to local MLLW (NOAA). Horizontal coordinates will be referenced to the Washington Coordinate System for proper North or South Zones NAD 83 (North American Datum 1983). Horizontal coordinates will be converted and identified as latitude and longitude (NAD 83) to the nearest 0.1 second.

5.6 Decontamination. The split-spoon, stainless steel compositing pans and sampling utensils will be thoroughly cleaned prior to use according to the following procedure:

- Wash with brush and Alconox soap
- Tap Water Rinse
- Rinse with distilled water
- Rinse with 10% nitric acid solution
- Rinse with methanol
- Rinse with distilled water

All hand work will be conducted with disposable latex gloves which will be rinsed with distilled water before and after handling each individual sample, as appropriate, to prevent sample contamination. Gloves will be disposed of between composites to prevent cross contamination between the DMMUs.

5.7 Volatiles Subsampling. For one randomly chosen core section from each composite, two subsamples will be removed for volatile organics testing immediately upon opening the split-spoon. The samples will be taken from along the entire length of the core section, from sediment which has not had contact with the split spoon.

Two separate 4-ounce containers will be completely filled with sample sediment for volatiles. No headspace will be allowed to remain in either container. Two samples are collected to ensure that an acceptable sample with no headspace is submitted to the laboratory for analysis. Prior to sampling, the containers, screw caps, and cap septa (silicone vapor barriers) will have been washed with detergent, rinsed once with tap water, rinsed at least twice with distilled water, and dried at $>105^{\circ}\text{C}$. A solvent rinse will not be used because it may interfere with the analysis.

To avoid leaving headspace in the containers, sample containers can be filled in one of two ways. If there is adequate water in the sediment, the vial will be filled to overflowing so that a convex meniscus forms at the top. Once sealed, the bottle will be inverted to verify the seal by demonstrating the absence of air bubbles. If there is little or no water in the sediment, jars will be filled as tightly as possible, eliminating obvious air pockets. With the cap liner's PTFE side down, the cap will be carefully placed on the opening of the vial, displacing any excess material.

The volatiles sampling jars will be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample, and referenced by entry into the log book

Table 5 contains those cores, randomly selected, which will be used to collect representative sediment for volatiles sampling.

Table 5. Random core sections for volatiles samples

DMMU	Random core section
C1	2A2
C2	3B1

5.8 Core Logging. After the volatiles sample has been taken, each discrete core section will then be inspected and described. For each split-spoon sample, the following data will be recorded on the core log:

- Depth interval of each core section as measured from MLLW.
- Sample recovery
- Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency of soil, color)
- Odor (e.g., hydrogen sulfide, petroleum products)
- Visual stratifications and lenses
- Vegetation
- Debris

- Presence of oil sheen
- Any other distinguishing characteristics or features

5.9 Compositing. After the core section has been logged, the remaining contents of the split-spoon will be placed in a stainless-steel pan and the pan covered with foil. Separate pans will be kept for surface and subsurface core sections and for the individual "Z" samples. Once all core sections for a composite have been collected and placed into the same stainless steel pan, the sample will be stirred and homogenized until a consistent color and texture is achieved.

At least 7 liters of homogenized sample will be prepared to provide adequate volume for laboratory analyses. Physical, chemical and bioassay samples will be taken from the same homogenate. Portions of each composite sample will be placed in appropriate containers obtained from the chemical and biological laboratories ("Z" samples will be archived for physical and chemical testing only). Each sample container will be clearly labeled with the project name, sample/composite identification, type of analysis to be performed, date and time, and initials of person(s) preparing the sample, and referenced by entry into the log book. See Table 6 for sample volume and storage information.

Approximately 15-20 additional liters of sediment would be required for bioaccumulation testing. This additional volume will not be collected at this time, as the requirement to conduct bioaccumulation testing is not anticipated.

5.10 Sample Transport and Chain-of-Custody Procedures. After sample containers have been filled they will be packed on blue ice in coolers. The coolers will be transferred to AmTest at the end of the day. Chain-of-custody procedures will commence in the field and will track delivery of the samples to AmTest. Specific procedures are as follows:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24.
- Individual sample containers will be packed to prevent breakage.
- The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler and SAIC's office name and address) to enable positive identification.
- A sealed envelope containing chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler.
- Signed and dated chain-of-custody seals will be placed on all coolers prior to shipping.

Upon transfer of sample possession to the compositing laboratory, the chain-of-custody form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the condition of the samples will be recorded by the receiver.

Table 6. Sample volume and storage

Sample Type	Holding Time	Sample Size ^a	Temperature ^b	Container	Archive ^c
Particle Size	6 Months	200g	4°C	1-liter Glass (combined)	X
Total Solids	14 Days	125g	4°C		
Total Volatile Solids	14 Days	125 g	4°C		
Total Organic Carbon	14 Days	125 g	4°C		
Metals (except Mercury)	6 Months	50 g	4°C		
Semivolatiles, Pesticides and PCBs	14 Days until extraction	150 g	4°C		
	1 Year until extraction		-18°C		
	40 Days after extraction		4°C		
Mercury	28 Days	5 g	-18°C	125 ml Glass	
Volatile Organics	14 Days	100 g	4°C	2-40 ml Glass	
Bioassay	8 Weeks	4 L	4°C	6-1 liter Glass ^d	

a. Required sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.

b. During transport to the lab, samples will be stored on blue ice.

c. For every DMMU, a 250 ml container is filled and frozen to run any or all of the analyses indicated.

d. Containers will be completely filled with no headspace allowed.

6.0 LABORATORY PHYSICAL AND CHEMICAL SEDIMENT ANALYSIS

The surface and subsurface composited samples will be analyzed for all the parameters listed in Appendix C and will be compared to PSDDA guidelines for open-water disposal, as well as the SMS sediment quality standards (SQS) to determine the potential for beneficial use.

6.1 Laboratory Analyses Protocols. Laboratory testing procedures will be conducted in accordance with the PSDDA Evaluation Procedures Technical Appendix, June 1988; the PSDDA Phase II Management Plan Report, September 1989; and with the PSEP Recommended Protocols. Several details of these procedures are discussed below.

6.1.1 Chain-of-custody. A chain-of-custody record for each set of samples will be maintained throughout all sampling activities and will accompany samples and shipment to the laboratory. Information tracked by the chain-of-custody records in the laboratory include sample identification number, date and time of sample receipt, analytical parameters required, location and conditions of storage, date and time of removal from and return to storage, signature of person removing and returning the sample, reason for removing from storage, and final disposition of the sample.

6.1.2 PSDDA Limits of Detection. For purposes of PSDDA testing, detection limits of all chemicals of concern must be below PSDDA screening levels. Failure to achieve this may result in a requirement to reanalyze or perform bioassays. The testing laboratory will be specifically cautioned by SAIC to make certain that it complies with the PSDDA detection limit requirements. All reasonable means, including additional cleanup steps and method modifications, will be used to bring all limits-of-detection below PSDDA SLs. In addition, an aliquot (250 ml) of each sediment sample for analysis will be archived and preserved at -18 C for additional analysis if necessary.

The following scenarios are possible and will be handled appropriately:

1. One or more chemicals-of-concern (COC) have limits of detection exceeding screening levels while all other COCs are quantitated or have limits of detection at or below the screening levels: the requirement to conduct biological testing would be triggered solely by limits of detection. In this case the chemical testing subcontractor will do everything possible to bring limits of detection down to or below the screening levels, including additional cleanup steps, re-extraction, etc. This is the only way to prevent unnecessary biological testing. If problems or questions arise, the chemical testing subcontractor will be directed to contact the Dredged Material Management Office.
2. One or more COCs have limits of detection exceeding screening levels for a lab sample, but below respective bioaccumulation triggers (BT) and maximum levels (ML), and other COCs have quantitated concentrations above screening levels: The need to do bioassays is based on the detected exceedances of SLs and the limits of detection above SL become irrelevant. No further action is necessary.
3. One or more COCs have limits of detection exceeding SL and exceeding BT or ML, and other COCs have quantitated concentrations above screening levels: the need to do bioassays is based on the detected exceedances of SLs but all other limits of detection must be brought below BTs and MLs to avoid the requirement to do bioaccumulation testing or special biological testing. As in case i) everything possible will be done to lower the limits of detection.

4. One COC is quantitated at a level which exceeds ML by more than 100%, or more than one COC concentration exceeds ML: there is reason to believe that the test sediment is unsuited for open-water disposal without additional chronic sublethal testing data: In the absence of chronic sublethal data, problems with limits of detection for other COCs are irrelevant. No further action is necessary.

In all cases, to avoid potential problems and leave open the option for retesting, sediments or extracts will be kept under proper storage conditions until the chemistry data is deemed acceptable by the PSDDA agencies.

6.1.3 SMS Limits of Detection. For purposes of comparison to SQS, a tiered approach will be used to evaluate detection limits:

- Detection limits will be compared to the July 1996 draft SMS detection limits. While the laboratory will be instructed to attempt to meet these recommended detection limits, it should be noted that some of these are very low (e.g. Aroclors) and may be unobtainable.
- If the recommended SMS detection limits cannot be met, a secondary comparison will be made directly to SQS, carbon-normalizing where appropriate.
- In addition, the 1988 dry-weight LAETs may be used if necessary to evaluate detection limits.

See Appendix C for a complete listing of these guidelines.

6.1.4 Sediment Conventional. All conventional parameters will be analyzed. Particle grain size distribution for each composite sample will be determined in accordance with ASTM D 422 (modified). Wet sieve analysis will be used for the sieve sizes U.S. No. 4, 10, 20, 40, 60, 140, 200 and 230. Hydrogen peroxide will not be used in preparations for grain-size analysis. Hydrometer analysis will be used for particle sizes finer than the 230 mesh. Water content will be determined using ASTM D 2216. Sediment classification designation will be made in accordance with U.S. Soil Classification System, ASTM D 2487.

6.1.5 Holding Times. The tiered testing option will be implemented for biological testing (see Section 7, Biological Testing). To the maximum extent practicable all chemical results will be provided within 28 days of sampling to allow a timely decision for tiered biological testing. Sediment samples reserved for potential bioassays will be stored under chain-of-custody by SAIC.

All samples for physical, chemical and biological testing will be maintained at the testing laboratory at the temperatures specified in Table 6 and analyzed within the holding times shown in the table.

6.1.6 Quality Assurance/Quality Control. The chemistry QA/QC procedures found in Table 7 will be followed.

6.2 Laboratory Written Report. A written report will be prepared by the analytical laboratory documenting all the activities associated with sample analyses. As a minimum, the following will be included in the report:

- Results of the laboratory analyses and QA/QC results.
- All protocols used during analyses.
- Chain of custody procedures, including explanation of any deviation from those identified herein.

- Any protocol deviations from the approved sampling plan.
- Location and availability of data.

As appropriate, this sampling plan may be referenced in describing protocols.

In addition, QA2 data required by Ecology for the SEDQUAL database will be submitted to the DMMO along with the report (see Appendix D for QA2 requirements).

Table 7. Minimum Laboratory QA/QC

Analysis Type	Method Blank ²	Duplicate ²	RM ^{2,4}	Matrix Spikes ²	Surrogates ⁷
Volatile Organics ¹	X	X ³		X	X
Semivolatiles ¹	X	X ³	X ⁵	X	X
Pesticides/PCBs ¹	X	X ³	X ⁵	X	X
Metals	X	X	X ⁶	X	
Total Organic Carbon	X	X	X ⁶		
Total Solids		X			
Total Volatile Solids		X			
Particle Size		X			

1. Initial calibration required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria. Ongoing calibration required at the beginning of each work shift, every 10-12 samples or every 12 hours (whichever is more frequent), and at the end of each shift.
2. Frequency of Analysis = one per batch
3. Matrix spike duplicate will be run
4. Reference Material
5. Canadian standard SRM-1
6. NIST certified reference material 2704
7. Surrogate spikes will be included with every sample, including matrix-spiked samples, blanks and reference materials

7.0 BIOLOGICAL TESTING

7.1 Bioassay Laboratory Protocols. The tiered testing approach will be used. Biological testing will be undertaken on any composite sample which has one or more chemicals of concern above the PSDDA screening level (SL). If more than one COC exceeds the PSDDA maximum level (ML) or if a single COC is greater than two times its ML, then biological testing will not be conducted. If any COC exceeds a bioaccumulation trigger (BT), a decision will be made as to whether or not to pursue biological testing. To the maximum extent practicable, chemical results will be provided for bioassay decisions within 28 days of first sample collection. The remaining four-week period will allow time for bioassay preparation as well as time for retests if necessary.

Bioassay testing requires that test sediments be matched and run with an appropriate PSDDA-approved reference sediment to factor out sediment grain-size effects on bioassay organisms. SAIC will coordinate with DMMO in making this match. Wet-sieving in the field, using a 63-micron sieve, will be utilized in identifying a suitable reference station.

The acute toxicity and chronic sublethal bioassays prescribed by PSDDA (amphipod, sediment larval, *Neanthes* growth) will be conducted on each sample identified for biological testing. All biological testing will be in strict compliance with *Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound sediments* (1995), with appropriate modifications as specified by PSDDA in the MPR-Phase II, public workshops and the annual review process. General biological testing procedures and specific procedures for each sediment bioassay are summarized below:

7.2 General Biological Testing Procedures.

7.2.1 Negative Controls. Negative control sediments are used in the amphipod and *Neanthes* bioassays to check laboratory performance. Negative control sediments are clean sediments in which the test organism normally lives and which are expected to produce low mortality. The sediment larval test utilizes a negative seawater control rather than a control sediment. The amphipod, sediment larval and *Neanthes* tests all have performance standards for negative controls, which are identified in Section 7.3.

7.2.2 Reference Sediment. All bioassays have performance standards for reference sediments (see Section 7.3). Failure to meet these standards may result in the requirement to retest. All reference sediments will be analyzed for total solids, total volatile solids, total organic carbon and grain-size.

7.2.3 Replication. Five laboratory replicates of test sediments, reference sediments and negative controls will be run for each bioassay.

7.2.4 Positive Controls. A positive control will be run for each bioassay. Cadmium chloride will be used for all three bioassays.

7.2.5. Interstitial salinity, ammonia and sulfides. For the *Neanthes* and amphipod bioassays, sacrificial beakers will be used to determine interstitial salinity, ammonia and sulfides for all test and reference sediments at the beginning and end of the test period.

7.2.6 Water Quality Monitoring. Water quality monitoring will be conducted for the amphipod, sediment larval and *Neanthes* bioassays. This consists of daily measurements of salinity, temperature, pH and dissolved oxygen for the amphipod and sediment larval tests. These measurements will be made every three days for the *Neanthes* bioassay. Overlying ammonia and sulfides will be determined at test

initiation and termination for the larval test. Monitoring will be conducted for all test and reference sediments and negative controls (including seawater controls). Parameter measurements must be within the limits specified for each bioassay. Measurements for each treatment will be made on a separate chemistry beaker set up to be identical to the other replicates within the treatment group, including the addition of test organisms.

7.3 Bioassay-specific Procedures.

7.3.1 Amphipod Bioassay. NW Aquatic Sciences will conduct this test, which involves exposing the amphipod *Rhepoxynius abronius*, *Ampelisca abdita* or *Eohaustorius estuarius* to test sediment for ten (10) days and counting the surviving animals at the end of the exposure period. Daily emergence data and the number of amphipods failing to rebury at the end of the test will be recorded as well. The control sediment has a performance standard of 10 percent mortality. The reference sediment has a performance standard of 20 percent mortality greater than control.

7.3.2 Sediment Larval Bioassay. This test monitors larval development of a suitable bivalve or echinoderm species (e.g. *Stronglyocentrotus purpuratus* or *Dendraster excentricus*) in the presence of test sediment. The test is run until the appropriate stage of development is achieved in a sacrificial seawater control (PSDDA MPR-Phase II, pp. 5-20). At the end of the test, larvae from each test sediment exposure are examined to quantify abnormality and mortality.

The seawater control has a performance standard of 30 percent combined mortality and abnormality. The reference sediment has a performance standard of 35 percent combined mortality and abnormality normalized to seawater control.

Initial counts will be made for a minimum of five 10-ml aliquots. Final counts for seawater control, reference sediment and test sediment will be made on 10-ml aliquots.

The sediment larval bioassay has a variable endpoint (not necessarily 48 hours) which is determined by the developmental stage of organisms in a sacrificial seawater control (PSDDA MPR Phase II, page 5-20).

Aeration will be conducted throughout the test to minimize effects from sulfides.

7.3.4 *Neanthes* Growth Test. This test utilizes the polychaete *Neanthes arenaceodentata*, in a 20-day growth test. The growth rate of organisms exposed to test sediments is compared to the growth rate of organisms exposed to a reference sediment. *Neanthes* will be obtained from Dr. Don Reish in Long Beach, California. *Neanthes* worms from Don Reish's lab may take 2 or 3 weeks to culture and deliver and will be ordered regardless of the outcome of the chemical characterization.

The control sediment has a performance standard of 10 percent mortality. The reference sediment has performance standards of 80 percent of the control growth rate and 20 percent mortality.

7.4 Interpretation. Test interpretations consist of endpoint comparisons to controls and reference on an absolute percentage basis as well as statistical comparison to reference. Test interpretation will follow the guidelines established in the PSDDA Management Plan Report-Phase II (page 5-17) for the amphipod and sediment larval bioassays, and the minutes of the dredging year 1991 annual review meeting for the *Neanthes* bioassay, as modified by subsequent annual review proceedings and workshops.

7.5 Bioassay Retest. Any bioassay retests must be fully coordinated with, and approved by, the PSDDA agencies. The DMMO will be contacted to handle this coordination.

7.6 Laboratory Written Report. A written report will be prepared by the biological laboratory documenting all the activities associated with sample analyses. As a minimum, the following will be included in the report:

- Results of the laboratory bioassay analyses and QA/QC results, including all DAIS data found in Appendix E.
- All protocols used during analyses, including explanation of any deviation from PSEP and the approved sampling plan.
- Chain of custody procedures, including explanation of any deviation from the identified protocols.
- Location and availability of data, laboratory notebooks and chain-of-custody forms.

As appropriate, this sampling plan may be referenced in describing protocols.

8.0 REPORTING

8.1 QA Report. The project quality assurance representative will prepare a quality assurance report based upon activities involved with the field sampling and review of the laboratory analytical data. The laboratory QA/QC reports will be incorporated by reference. This report will identify any field and laboratory activities that deviated from the approved sampling plan and the referenced protocols and will make a statement regarding the overall validity of the data collected. The QA/QC report will be incorporated into the Final Report.

8.2 Final Report. A written report shall be prepared by SAIC documenting all activities associated with collection, compositing, transportation of samples, and chemical and biological analysis of samples. The chemical and biological reports will be included as appendices. As a minimum, the following will be included in the Final Report:

- Type of sampling equipment used.
- Protocols used during sampling and testing and an explanation of any deviations from the sampling plan protocols.
- Descriptions of each sample.
- Locations where the sediment samples were collected. Locations will be reported in latitude and longitude to the nearest tenth of a second.
- A plan view of the project showing the actual sampling location.
- Chain of-custody procedures used, and explanation of any deviations from the sampling plan procedures.
- Description of sampling and compositing procedures.
- Final QA report for Section 8.1 above.
- Chemical and biological testing data, with comparisons to PSDDA and SMS guidelines.
- QA2 data required by the Department of Ecology for data validation prior to entering data in their Sediment Quality database. These data are listed in Appendix D.
- Sampling and analysis cost data will be submitted upon project completion on forms provided by the Dredged Material Management Office.

9.0 REFERENCES

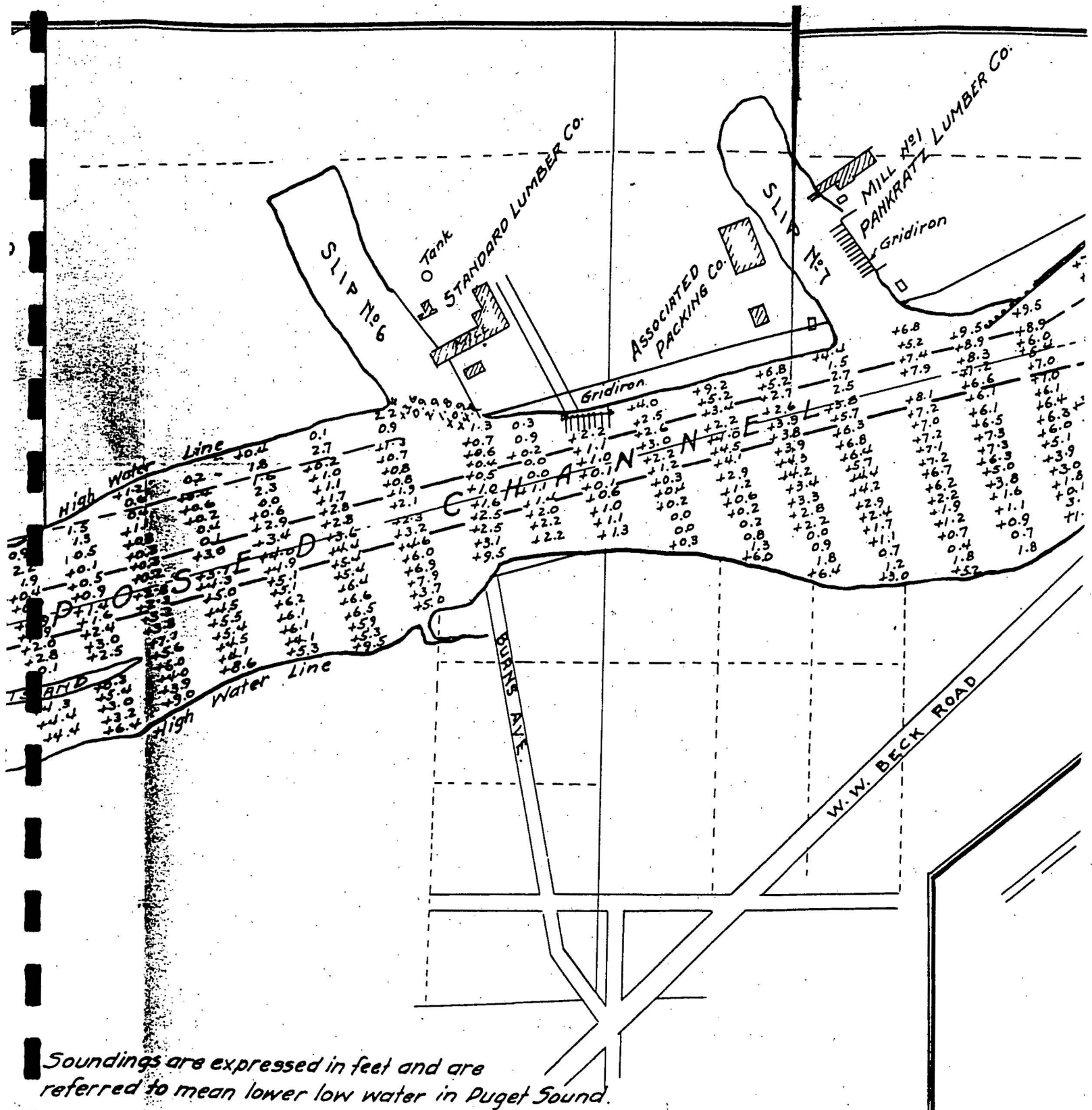
PSEP, *Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound*, 1986-1996, Puget Sound Estuary Program.

PSDDA, 1988. *Evaluation Procedures Technical Appendix - Phase I*, prepared by the PSDDA agencies.

Weston, 1990. *Baseline Soil and Groundwater Quality Assessment, Seattle City Light Long-Term Lease Option, Seattle, Washington*. Prepared for Boeing Environmental Affairs, Seattle, Washington by Roy F. Weston, Inc., Seattle, Washington.

APPENDIX A

Historical Maps and Photographs



DUWAMISH WATERWAY
 ABOVE
 FOURTEENTH AVE., SOUTH
 CONDITION OCTOBER 22, 1928.

SCALE: 1" = 400'

100' 0 2 4 6 8 10 1200'

Surveyed by F.S.G.

Figure A1

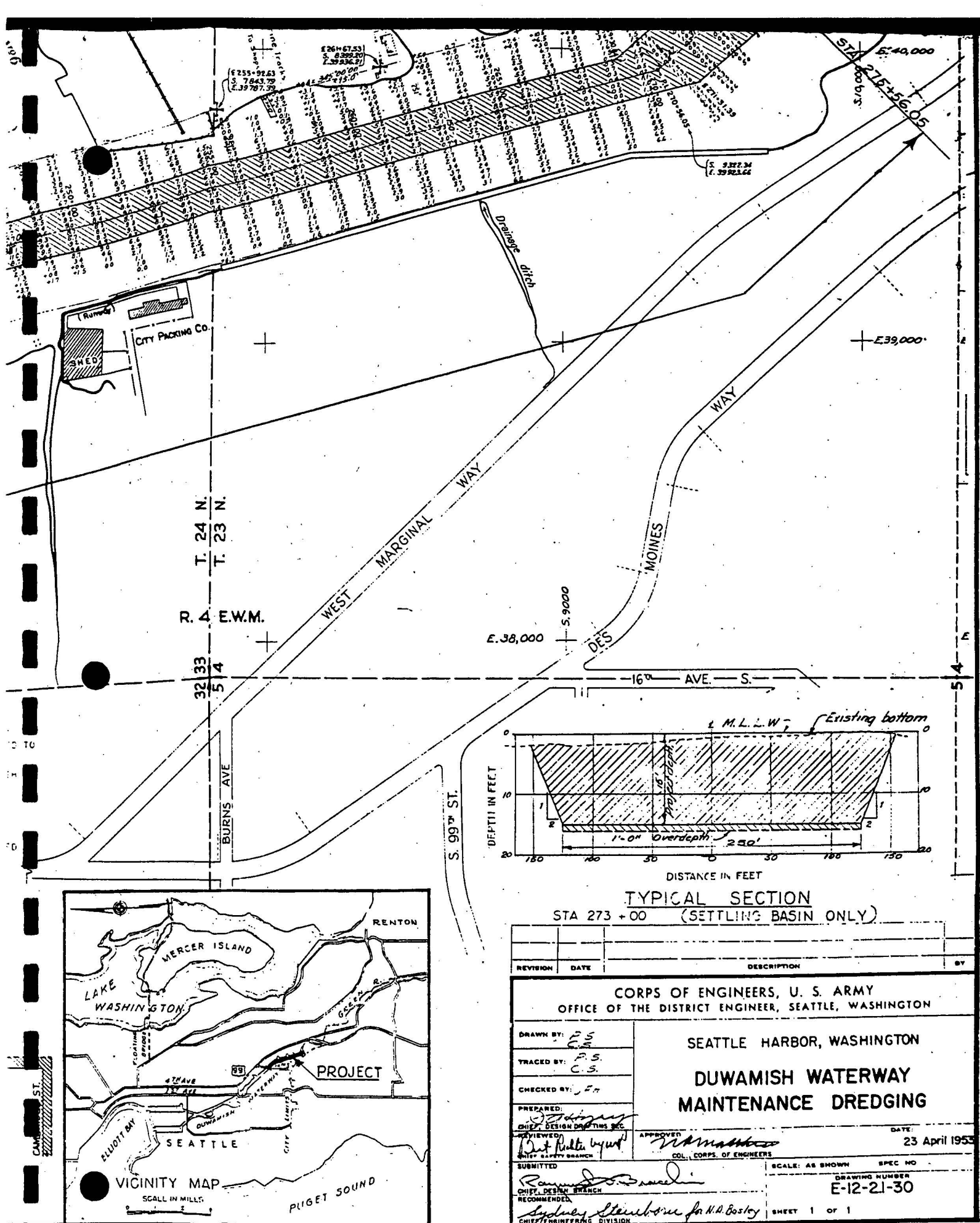
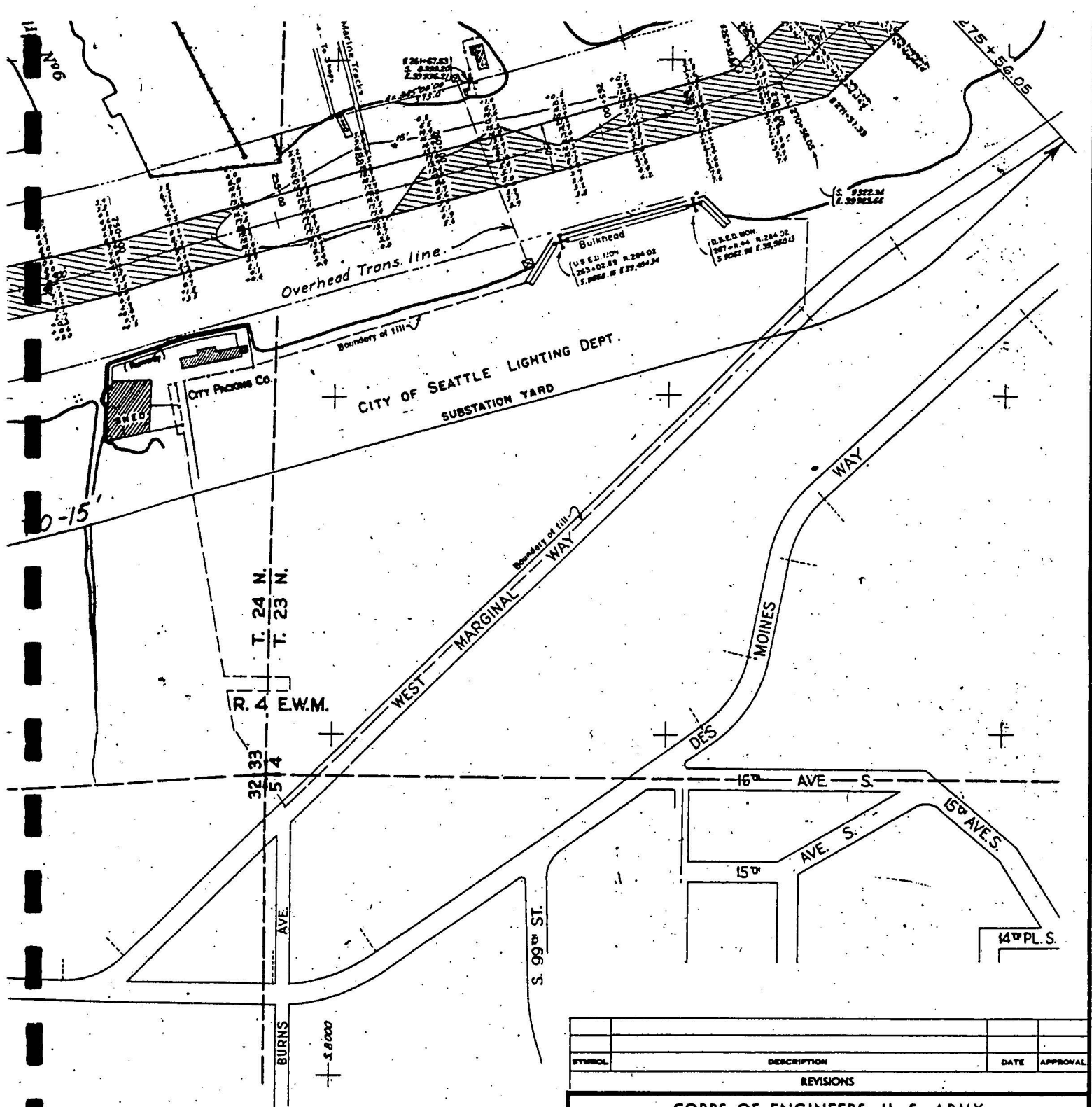


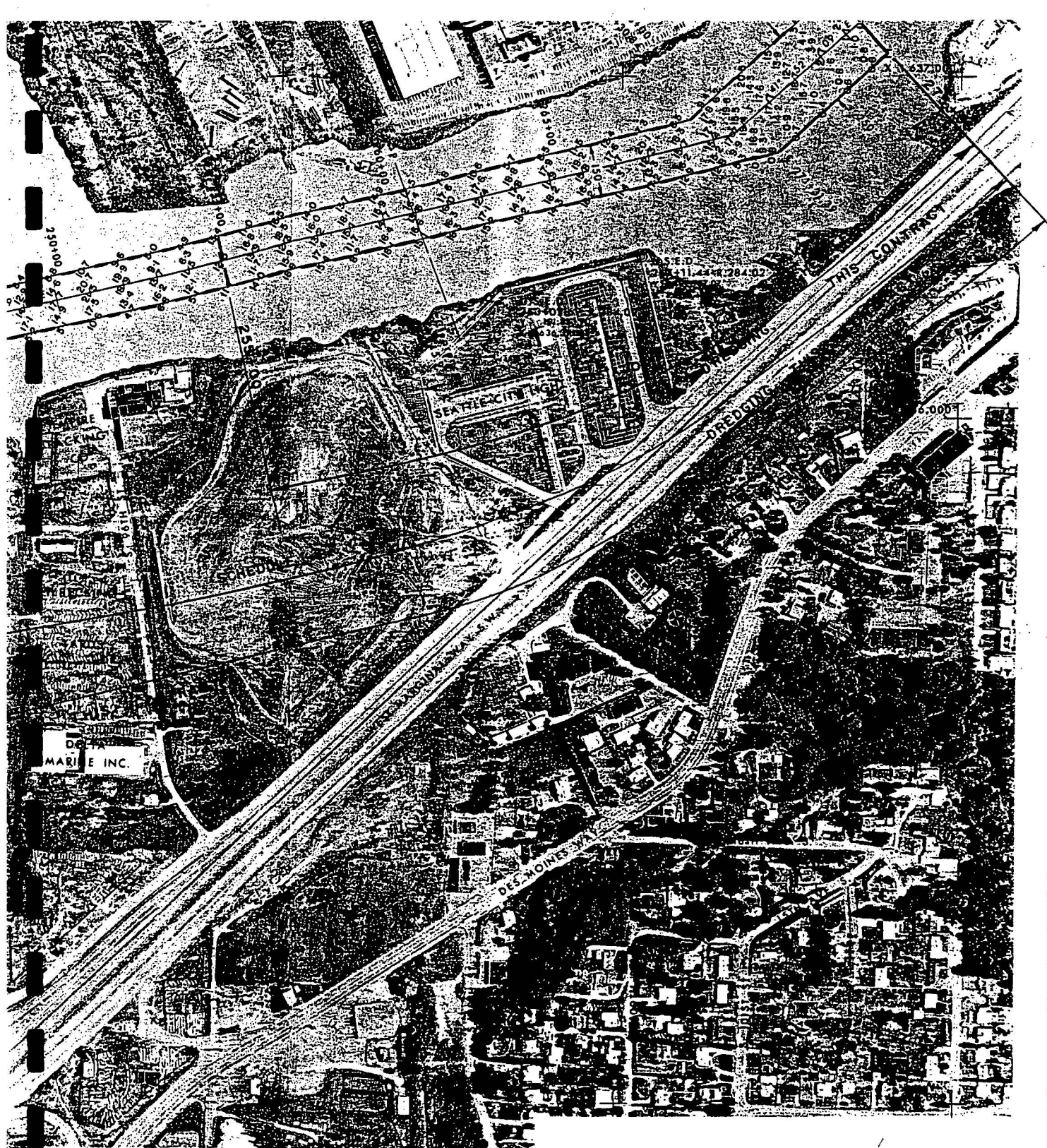
Figure A2



SYMBOL	DESCRIPTION	DATE	APPROVAL
REVISIONS			

CORPS OF ENGINEERS, U. S. ARMY OFFICE OF THE DISTRICT ENGINEER, SEATTLE, WASHINGTON			
DRAWN BY: F.D.M.		SEATTLE HARBOR, WASHINGTON	
TRACED BY: D.A.L.		DUWAMISH WATERWAY	
CHECKED BY: W.L.P.		MAINTENANCE DREDGING	
PREPARED BY: Carl L. Fein CHIEF, DRAFTING SECT.		DETAIL PLAN III	
REVIEWED BY: Paul R. Ricketts CHIEF, SAFETY BRANCH		APPROVED FOR THE DISTRICT ENGINEER: James A. Boudry CHIEF, ENGINEERING DIVISION	
SUBMITTED BY: Frank L. Lash ASST. FOR CIVIL WORKS, DESIGN BRANCH		DATE: 4 Apr 1957	
RECOMMENDED BY: Hudson Steinhilber CHIEF, DESIGN BRANCH		SCALE: AS SHOWN	
		SPEC. NO.	
		DRAWING NUMBER E-12-2.1-41	
		SHEET 4 of 4	

Figure A3



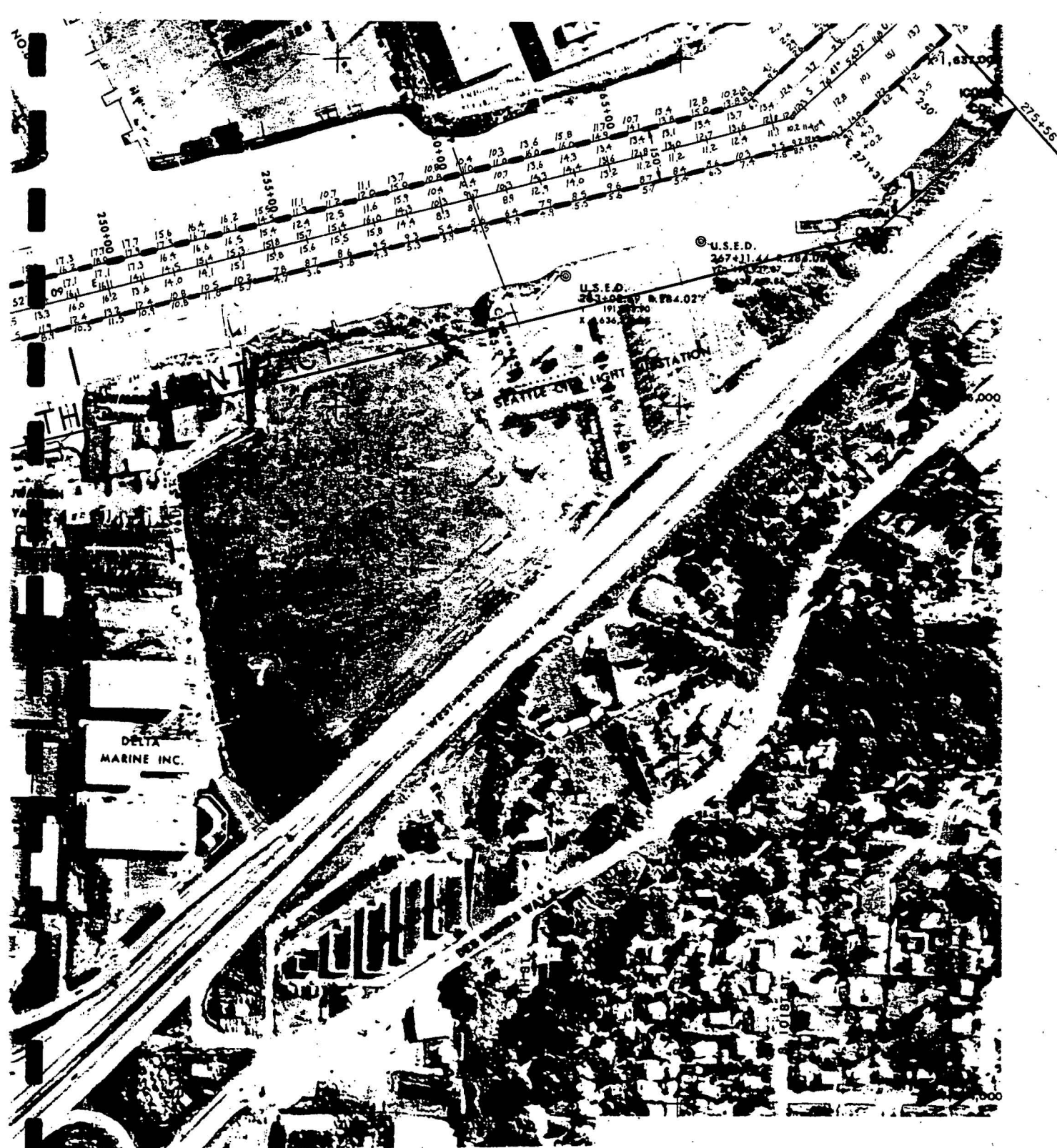
flown: 17 Sept 1971

PLAN
SCALE IN FEET
200' 0 200' 400'

PREPARED BY: *[Signature]*
CHIEF CIVIL DESIGN SECTION
SUBMITTED BY: *[Signature]*
CHIEF DESIGN BRANCH
DATE: 75 NOV 21

Figure A5

U. S. ARMY ENGINEER DISTRICT, SEATTLE CORPS OF ENGINEERS SEATTLE, WASHINGTON			
FY 76 MAINTENANCE DREDGING			
DETAIL PLAN AND SECTION DUWAMISH WATERWAY			
SEATTLE HARBOR		WASHINGTON	
SIZE	INVITATION NO.	FILE NO.	PLATE
F		E-12-2.1-74	
DSGN	LUNDY	CHE. HANSON	SHEET 2



1" = 200'

200' 0 200' 400'

The information depicted on this map represents the results of Surveys made in FEBRUARY, 1983 and can only be considered as indicating an estimated condition existing at the time of this Survey.

Horizontal control based on Lambert grid projection for Washington North Zone.

Soundings and elevations are in feet and are referred to plane of Mean Lower Low Water.

Soundings taken above the datum plane are prefixed with (+) sign.

Photo-Map prepared by Survey Branch, Engineering Division, C. of E.

Photography flown: 1 JULY 1980

Figure A6

U. S. ARMY ENGINEER DISTRICT, SEATTLE CORPS OF ENGINEERS SEATTLE, WASHINGTON				
FY 84 MAINTENANCE DREDGING				
DETAIL PLAN I				
DUWAMISH WATERWAY				
SEATTLE HARBOR			WASHINGTON	
SIZE	INVITATION NO.	FILE NO.	DATE:	PLATE
		E-12-21-89	83 JULY 31	
DSGN. PARRY		CHK. SUMER	SHEET 2 of 2	

APPENDIX B

Baseline Soil and Groundwater Quality Assessment Seattle City Light Long-Term Lease Option Seattle, Washington

**BASELINE SOIL AND GROUNDWATER QUALITY ASSESSMENT
SEATTLE CITY LIGHT LONG-TERM LEASE OPTION
SEATTLE, WASHINGTON**

Prepared for

**Boeing Environmental Affairs
Seattle, Washington**

**WO 3709-04-01
23 May 1990**

Prepared by

**Roy F. Weston, Inc.
Suite 500
201 Elliott Avenue West
Seattle, Washington 98119**

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BASELINE SOIL AND GROUNDWATER QUALITY ASSESSMENT SEATTLE CITY LIGHT LONG-TERM LEASE OPTION SEATTLE, WASHINGTON

1.0 INTRODUCTION

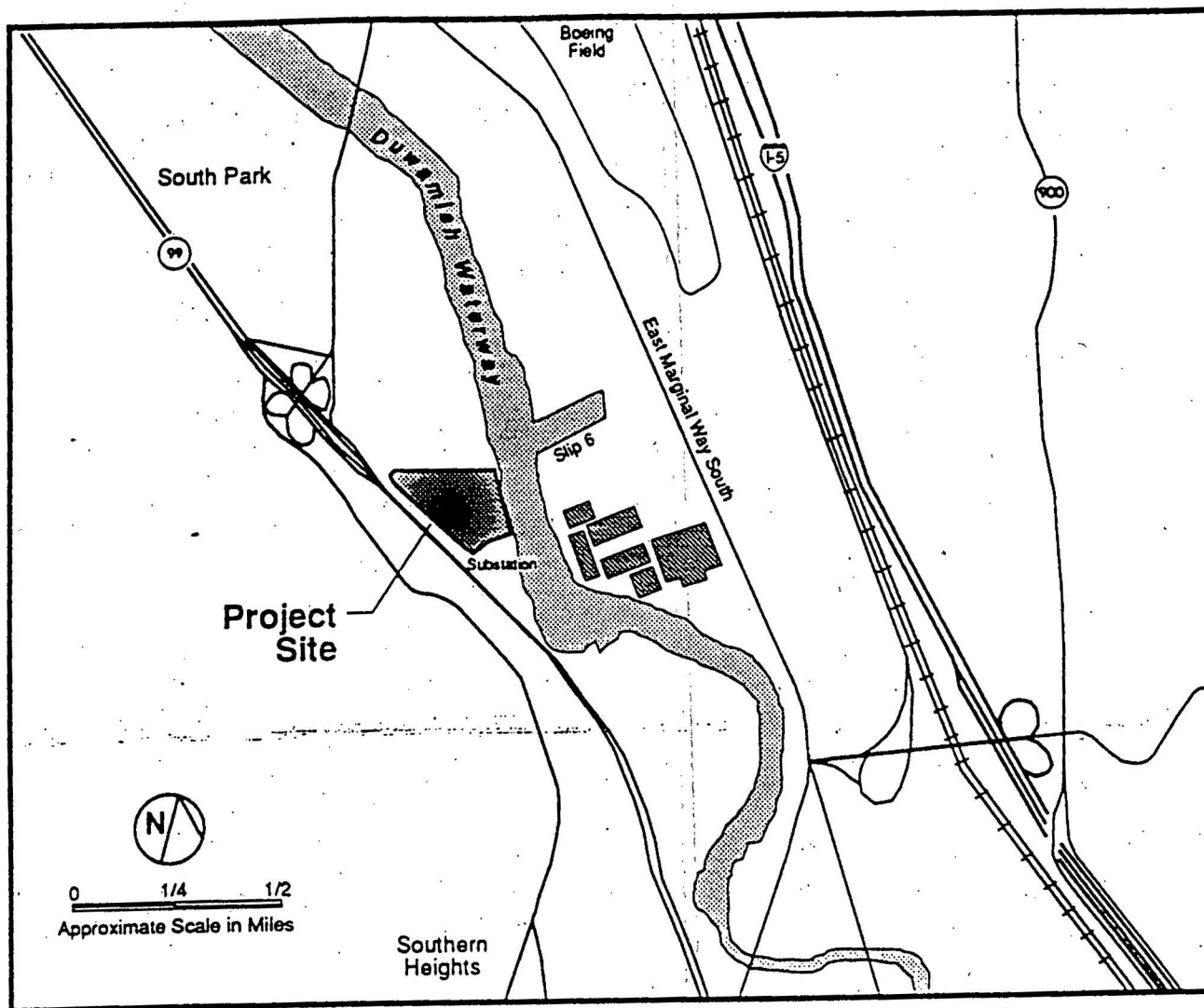
This report contains Roy F. Weston Inc.'s (WESTON's) findings from the baseline soil and groundwater quality assessment for the Seattle City Light (SCL) long-term lease option. The work was accomplished in accordance with our proposal dated 10 April 1990, and as modified by The Boeing Company (Boeing) and WESTON during the course of the field work.

1.1 Background

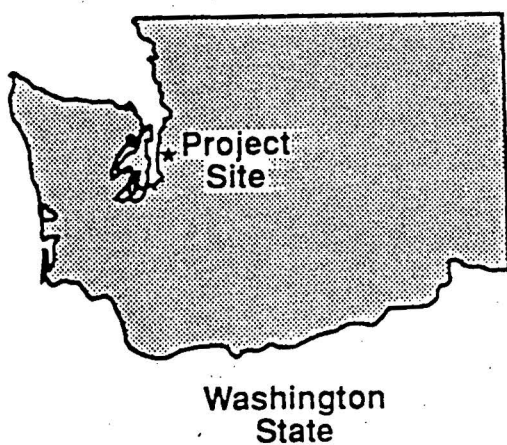
Boeing is evaluating an option to enter into a 50-year lease agreement with SCL on property adjoining SCL's Duwamish substation at 10000 West Marginal Place South. The undeveloped property is located on the Duwamish Waterway in Seattle, Washington (Figure 1).

We understand that the property was undeveloped in the 1930s (as indicated by aerial photographs) and that Corps of Engineers' records indicate that dredged sediment from the Duwamish Waterway was placed across the property in 1968. We also understand that dredged sediment was placed in the east-central portion of the property in 1985 from dredging of the Duwamish Yacht Club marina located north of the property.

Analysis of soil samples collected from the 1968 fill on SCL property immediately north of the lease option indicates that polychlorinated biphenyls (PCBs) and pentachlorophenols (PCPs) were undetected (i.e., below 0.01 ppm), that the samples were not state dangerous waste for halogenated hydrocarbons or polycyclic aromatic hydrocarbons (PAHs), and that they were not EP toxic for metals (Raven Systems & Research, Inc., 30 December 1987). Analysis of a composite soil sample from the 1985 dredge fill on the lease option revealed concentrations of 0.05 mg/kg PCBs and less than 10 mg/kg halogenated hydrocarbons. The 1985 dredge fill sample also contained less than state-regulated concentrations of PAHs and was not EP toxic for metals (Laucks Testing Laboratory, Laboratory No. 90364, 18 July 1985).



Vicinity Map



Project Site
Locator Map

Figure
1

1.2 Purpose and Objectives

The purpose of this work is to support Boeing's due diligence effort in assessing the property and to provide a baseline for comparing and assessing soil and groundwater quality conditions at the property after lease termination. The purpose of the sampling and analytical program strategy was to minimize the overall number of media samples, while maximizing the likelihood of detection of organic compounds or metals in each media.

The soil and groundwater quality assessment was designed to achieve the following objectives:

- o Assess soil quality along the fence line of the substation for PCBs and chlorinated herbicides based on their potential use at the substation and potential migration onto the lease property.
- o Assess soil quality in the 1968 dredge fill for arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, copper, tin, and PAHs. These parameters were selected based on the prevalent contaminants identified elsewhere in the Duwamish Waterway area. Copper and tin were included because of their potential adverse affects on aquatic life.
- o Assess soil quality in the 1985 dredge fill for the ten metals, semivolatile organic compounds, and PCBs. The full semivolatile scan (i.e., base/neutral/acid extractable fractions) was recommended based on typical practices/activities associated with marinas.
- o Assess groundwater quality beneath the property for volatile organic compounds (VOCs) and conventional water quality parameters. Groundwater was analyzed for VOCs to assess potential releases of fuels or solvents from the substation or other off-site sources and/or from the dredge fill. Conventional parameters were sampled to assess baseline conditions and the influence, if any, of seawater from the waterway.

1.3 Summary of Findings

Seven soil borings (6 to 20 feet deep) were drilled and sampled on the property on 17 and 18 April 1990. Composite soil samples from each boring were analyzed for PAHs and metals. Samples from the 1985 dredge fill area were additionally analyzed for PCBs. Low levels of a few PAHs and several metals were detected in the soil samples at concentrations below the most stringent applicable regulations (i.e., draft Washington Model Toxics Control Act Cleanup Regulations). PCBs were not detected in the 1985 dredge fill samples.

Three of the borings were completed as monitoring wells. The wells were sampled for groundwater and analyzed for VOCs and selected conventional groundwater quality parameters. Acetone, present at a very low concentration in one well, was the only VOC detected in the samples.

Five composite surface soil samples were collected along the substation fence line and analyzed for PCBs and chlorinated herbicides. Neither PCBs nor herbicides were detected in any of the samples at detection limits that were well below regulatory clean-up levels.

No regulated concentrations of organic compounds or metals were detected in samples from the property. The low levels of PAHs and metals present in some of the samples are probably representative of background concentrations in dredge fill in the Duwamish industrial area.

No further sampling at the property is recommended.

WESTON performed this work and prepared this report in accordance with generally accepted professional practices, related to the nature of the work accomplished, for the exclusive use of Boeing for the specific application to the proposed SCL property. No other warranty, expressed or implied, is made.

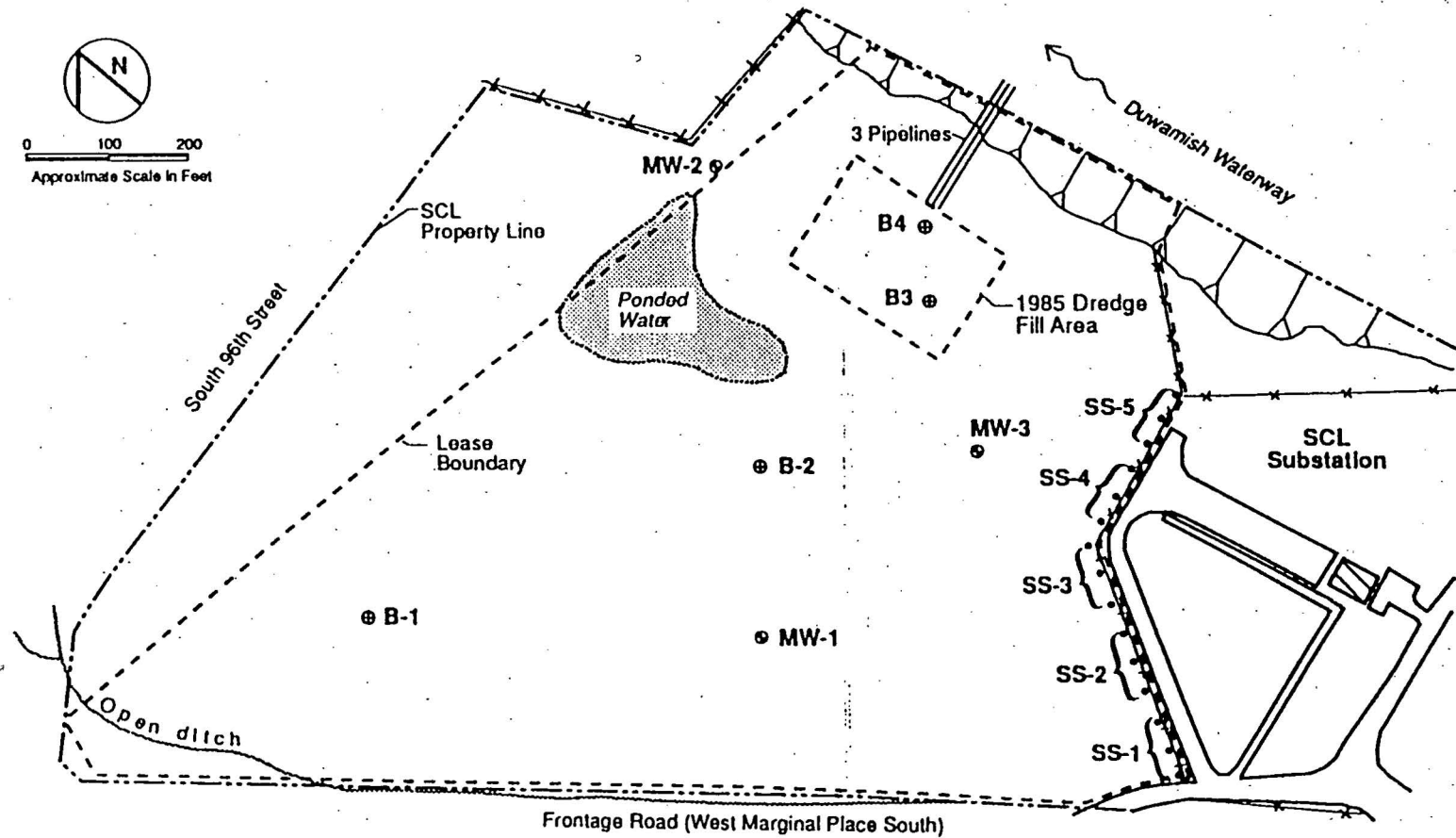
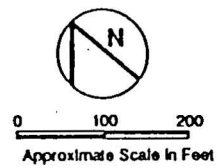
2.0 SITE ASSESSMENT

2.1 General Property Description

The property comprises approximately 20 acres of open grassy field. It is bounded to the south by SCL's Duwamish substation, to the north by the Delta Marine Industries facilities, to the east by the Duwamish Waterway, and to the west by West Marginal Place South, a frontage road of Highway 99 (Figure 2). The west and south portions of the property are crossed by several high-voltage power lines. An open ditch runs along the west boundary of the property. Photographs of the property are included in Appendix C.

The majority of the property is nearly level. A rectangular depression, approximately 200 feet on a side, is located in the east-central portion of the lease property. The depression apparently marks the area filled with dredged sediment in 1985. The depression appears to be an infilled impoundment in which dredged sediment was placed and allowed to drain.

An area of seasonally ponded water was located in the central portion of the property and noticeably decreased in size during the course of the site investigation.



Explanation

- ⊕ B-1 Hand Auger boring location
- ⊙ MW-1 Monitoring well location
- SS-1 Surface soil sample location

Site Map and Sampling Locations

FIGURE

2

The easternmost portion of the property along the Duwamish Water contains several exposures of milled lumber debris mixed with sandy and clayey silt fill. The lumber-containing fill appears to be a separate fill unit from the 1968 or 1985 fills, although this is uncertain because the relationship between the fill units along the waterway is obscured by vegetation and recent sedimentation. Several decayed pilings are present along the waterway shoreline.

2.2 Subsurface Stratigraphy

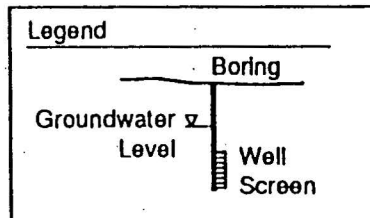
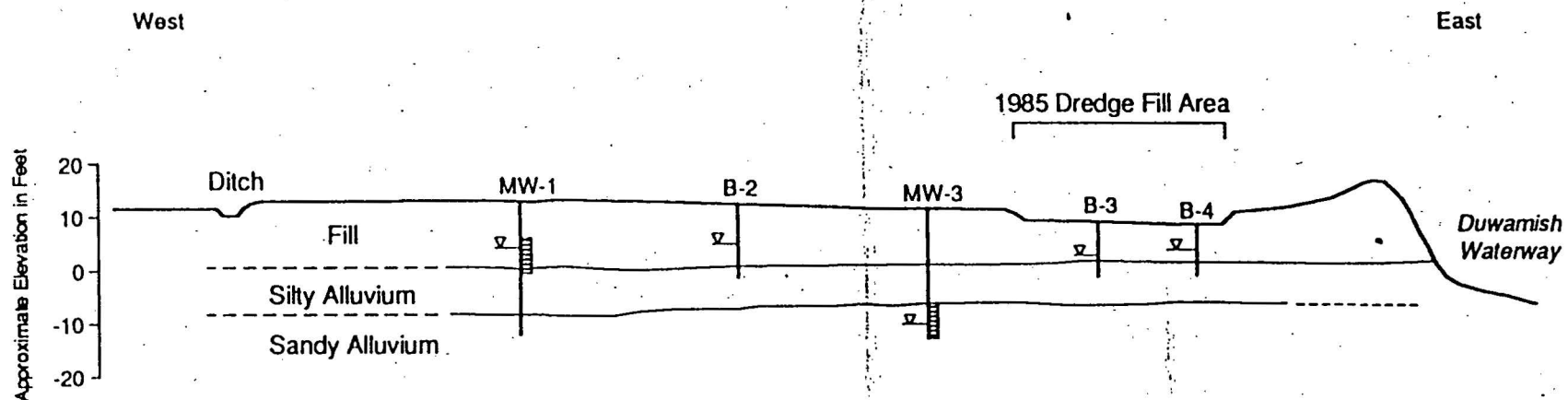
Seven soil borings were drilled on the property (Figure 2). Three of the borings, designated MW-1 through MW-3, were drilled to a depth of approximately 20 feet using a mechanical drill rig and were completed as monitoring wells on 17 April 1990. Four of the borings, designated B-1 through B-4, were drilled to depths of 6 to 10 feet using hand-auger techniques. Borings B-3 and B-4 were located in the 1985 dredge fill area. All of the other borings were completed in the 1968 dredge fill area. A discussion of drilling, sampling, and decontamination procedures used at the site are provided in Appendix A. Exploration logs of the borings are also presented in Appendix A.

The subsurface investigation indicates that the property is underlain by approximately 5 to 10 feet of stratified, heterogeneous fill that, in turn, overlies alluvium of the Duwamish River floodplain (Figure 3). Apart from the man-made levee along the present bank of the Duwamish Waterway, the fill appears to thicken progressively westward across the property. The fill is thinnest (5.5 to 6.2 feet) in the topographic depression in the east portion of the property that apparently coincides with the limits of the 1985 dredge fill.

Relatively little lithologic or textural difference was noted between the 1968 and 1985 fills. The fill is composed predominantly of crudely layered silty sand and clayey silt. The upper 1 to 4 feet of the fill is typically a loose to medium-dense, moist, brown, silty sand. Dense, black, carbonaceous, fine sand and stiff, black, clayey silt typically occur beneath the surface layer. The black sand and silt often contain abundant wood fragments. In some borings, a saturated, gray, well-graded sand layer 0 to 4 feet thick occurs at or near the base of the fill.

Fill overlying alluvium was also observed in an eroded exposure along the west bank of the Duwamish Waterway. Very abundant milled lumber debris occurs in a sandy to clayey matrix at low elevations along the bank and may be a separate fill unit from the 1968 and 1985 dredge fill units described here.

Alluvium underlying the fill consists of approximately 2 to 3 feet of gray, mottled, massive, clayey silt that often contains plant fragments. Below the mottled clayey silt is a 1.5- to 4-foot-thick unit composed of thinly bedded, gray and brown, clayey silt and fine sand. In the three deepest borings, (i.e., MW-1, MW-2, and MW-3), a



0 100 200
Approximate Horizontal
Scale in Feet

**Subsurface Geologic Section
Seattle City Light Lease Option**

minimum of 3 to 7 feet of saturated, gray sand is present at the base of the explorations. The total thickness of this sand unit at the site is not known because it was not fully penetrated by any of the borings. The alluvium is interpreted to be fine-grained bioturbated and stratified overbank deposits and coarser channel sands of the Duwamish River.

2.3 Groundwater

Groundwater was encountered in all seven borings. A discontinuous, water-bearing zone occurred within the lower portion of the fill unit in Borings MW-1, B-1, B-2, B-3, and B-4. Depth to water varies from 3 to 6.5 feet below ground surface. This upper water-bearing zone results from the contrasting permeability of the fill sand and the underlying fine-grained unit that retards downward migration of groundwater. The water-bearing zone within the fill immediately overlies the massive, mottled, clayey silt unit of the native alluvium. Well MW-1 is screened across this water-bearing zone within the fill. Water-bearing zones within the fill were not observed in the borings for Wells MW-2 and MW-3.

A second water-bearing zone occurs within the sand unit that is located below a depth of approximately 13 feet in the sandy alluvium. This deeper water-bearing zone extends beneath the property and may be in hydraulic communication with the Duwamish Waterway. Wells MW-2 and MW-3 are both screened within this unit. Depth to water in this unit varied from 11.6 feet at Well MW-2 to 15.8 feet at Well MW-3. Groundwater flow direction in this unit could not be determined because three water level measurement points were not available. Groundwater flow at the site is most likely northeastward towards the Duwamish Waterway.

Based on the difference in water levels between Well MW-1 and Wells MW-2 and MW-3, the saturated zones within the fill and the alluvium do not appear to be connected.

2.4 Sampling Along the SCL Substation Fence Line

Five composite surface samples were collected along the north side of the fence separating the SCL substation from the lease option property. A discussion of the specific sampling and decontamination procedures used is provided in Appendix A.

The ground surface along the fence line is covered with approximately 2 to 4 inches of clean, coarse gravel. The underlying soil consisted of grayish brown, slightly silty sand fill. No staining of or odors from the soil were noted during sampling. Analytical results for the samples are presented in Section 3.

3.0 ANALYTICAL RESULTS

All samples were analyzed by Laucks Testing Laboratories, Seattle, Washington. Complete analytical results are presented in Appendix B and Tables 1 through 8. A summary of those analytes detected is presented in Table 9.

3.1 1968 Dredge Fill Area

Subsurface soil samples composited from the five borings in the 1968 dredge fill area (i.e., Borings MW-1, MW-2, MW-3, B-1, and B-2) were analyzed for PAHs and metals. The high molecular weight PAH compound benzo(a)pyrene was detected in three of the five boring samples (MW-1, MW-3, and B-1) at concentrations of 96 to 340 ug/kg. Pyrene was detected in only one boring sample (MW-3) at a concentration of 74 ug/kg. Bis(2-ethylhexyl)phthalate was detected in all five boring samples at concentrations of 87 to 490 ug/kg. No other base/neutral-extractable semivolatile compounds were detected in the composite samples from each boring.

Several metals were detected in each of the five boring samples. Metal concentrations in the samples are well within the ranges observed in natural soils by WESTON personnel in the Puget Sound region.

3.2 1985 Dredge Fill Area

Subsurface soil samples composited from the two borings in the 1985 dredge fill area (i.e., Borings B-3 and B-4) were analyzed for PCBs, semivolatile organic compounds, and metals. PCBs were not found in the samples at detection limits that range from 80 to 210 ug/kg. The PAH compounds fluoranthene (70 ug/kg), phenanthrene (53 ug/kg), pyrene (86 ug/kg), and benzo(a)pyrene (250 ug/kg) were detected in the sample from Boring B-3. Bis(2-ethylhexyl)phthalate was detected in the samples from both borings at concentrations of 440 and 380 ug/kg. No other semivolatile organic compound was detected in the sample from Boring B-4. Several metals were detected in the two boring samples. The concentration of mercury in the sample from Boring B-3 (0.51 ug/kg) appears to be slightly elevated with respect to the typical range found in natural soils of the Puget Sound region. All other metal concentrations in the two samples are well within the ranges observed in natural soils by WESTON personnel in the Puget Sound region.

3.3 Groundwater

The three groundwater samples collected from Wells MW-1, MW-2, and MW-3 on 26 April 1990 were analyzed for VOCs and selected conventional water quality parameters (i.e., alkalinity, chloride, sulfate, sodium, iron, manganese). The only VOC detected in any of the water samples was acetone, at a concentration of 8 ug/l in Well MW-1.

TABLE 1
SUBSURFACE SOIL SAMPLES - TOTAL METALS
1968 AND 1985 DREDGE FILL AREAS
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*						
	MW-1	MW-2	MW-3	B-1	B-2	B-3	B-4
Arsenic	4.9	4.2	7.5	5.9	4.8	8.7	5.6
Barium	50.0	76.0	67.0	56.0	42.0	74.0	50.0
Cadmium	1.0	1.3	1.3	0.9	0.5 u	1.2	0.6
Chromium	15.0	17.0	20.0	13.0	12.0	18.0	13.0
Copper	20.0	36.0	36.0	19.0	17.0	33.0	20.0
Lead	7.3	15.0	16.0	8.7	8.2	17.0	7.4
Mercury	0.1 u	0.1 u	0.24	0.1 u	0.1 u	0.51	0.1 u
Selenium	0.5 u	0.5 u	0.8	0.5	0.5 u	0.5 u	0.5 u
Silver	1.0 u	1.0 u	1.0 u	1.0 u	1.0 u	1.0 u	1.0 u
Tin	50.0 u	50.0 u	50.0 u	50.0 u	50.0 u	50.0	50.0 u

*Parts per million (mg/kg), dry basis.

u - indicates the analyte of interest was not detected,
to the limit of detection shown.

TABLE 2
SUBSURFACE SOIL SAMPLES - PAHs
(Base/Neutral Fractions of Semivolatile Extractables)
1968 DREDGE FILL AREA
SEATTLE CITY LIGHT LEASE OPTION .

Analyte	Sample*				
	MW-1	MW-2	MW-3	B-1	B-2
Aniline	200 u	210 u	230 u	220 u	210 u
Bis(2-Chloroethyl)Ether	39 u	43 u	45 u	43 u	41 u
1,3-Dichlorobenzene	39 u	43 u	45 u	43 u	41 u
1,4-Dichlorobenzene	39 u	43 u	45 u	43 u	41 u
1,2-Dichlorobenzene	39 u	43 u	45 u	43 u	41 u
Bis(2-Chloroisopropyl)Ether	39 u	43 u	45 u	43 u	41 u
N-Nitroso-Di-n-Propylamine	39 u	43 u	45 u	43 u	41 u
Hexachloroethane -	79 u	86 u	90 u	87 u	83 u
Nitrobenzene	39 u	43 u	45 u	43 u	41 u
Isophorone	39 u	43 u	45 u	43 u	41 u
Bis(2-Chloroethoxy)Methane	39 u	43 u	45 u	43 u	41 u
1,2,4-Trichlorobenzene	39 u	43 u	45 u	43 u	41 u
Naphthalene	79 u	86 u	90 u	87 u	83 u
4-Chloroaniline	39 u	43 u	45 u	43 u	41 u
Hexachlorobutadiene	39 u	43 u	45 u	43 u	41 u
2-Methylnaphthalene	39 u	43 u	45 u	43 u	41 u
Hexachlorocyclopentadiene	79 u	86 u	90 u	87 u	83 u
2-Chloronaphthalene	39 u	43 u	45 u	43 u	41 u
2-Nitroaniline	79 u	86 u	90 u	87 u	83 u
Dimethyl Phthalate	39 u	43 u	45 u	43 u	41 u
Acenaphthylene	39 u	43 u	45 u	43 u	41 u
2,6-Dinitrotoluene	79 u	86 u	90 u	87 u	83 u
3-Nitroaniline	200 u	210 u	230 u	220 u	210 u
Ancaphthene	39 u	43 u	45 u	43 u	41 u
Dibenzofuran	39 u	43 u	45 u	43 u	41 u
2,4-Dinitrotoluene	79 u	86 u	90 u	87 u	83 u

*Parts per million (mg/kg), dry basis.

u - indicates the analyte of interest was not detected,
to the limit of detection shown.

TABLE 2 (Continued)
 SUBSURFACE SOIL SAMPLES - PAHs
 (Base/Neutral Fractions of Semivolatile Extractables)
 1968 DREDGE FILL AREA
 SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*				
	MW-1	MW-2	MW-3	B-1	B-2
Diethyl Phthalate	39 u	43 u	45 u	43 u	41 u
4-Chlorophenyl-Phenylether	39 u	43 u	45 u	43 u	41 u
Fluorene	39 u	43 u	45 u	43 u	41 u
4-Nitroaniline	79 u	86 u	90 u	87 u	83 u
N-Nitrosodiphenylamine	39 u	43 u	45 u	43 u	41 u
1,2-Diphenylhydrazine	79 u	86 u	90 u	87 u	83 u
4-Bromophenyl-Phenylether	79 u	86 u	90 u	87 u	83 u
Hexachlorobenzene	39 u	43 u	45 u	43 u	41 u
Phenanthrene	39 u	43 u	45 u	43 u	41 u
Anthracene	39 u	43 u	45 u	43 u	41 u
Di-n-Butyl Phthalate	39 u	43 u	45 u	43 u	41 u
Fluoranthene	39 u	43 u	45 u	43 u	41 u
Pyrene	39 u	43 u	74	43 u	41 u
Benzidine	980 u	1100 u	1100 u	1100 u	1100 u
Butylbenzylphthalate	39 u	43 u	45 u	43 u	41 u
3,3'-Dichlorobenzidine	390 u	430 u	450 u	430 u	410 u
Benzo(a)Anthracene	39 u	43 u	45 u	43 u	41 u
Chrysene	39 u	43 u	45 u	43 u	41 u
Bis(2-Ethylhexyl)Phthalate	87	160	340	390	490
Di-n-Octyl Phthalate	39 u	43 u	45 u	43 u	41 u
Benzo(b)Fluoranthene	79 u	86 u	90 u	87 u	83 u
Benzo(k)Fluoranthene	79 u	86 u	90 u	87 u	83 u
Benzo(a)Pyrene	96	86 u	340	140	83 u
Indeno(1,2,3-cd)Pyrene	79 u	86 u	90 u	87 u	83 u
Dibenzo(a,h)Anthracene	79 u	86 u	90 u	87 u	83 u
Benzo(g,h,i)Perylene	79 u	86 u	90 u	87 u	83 u

*Parts per billion (ug/kg), dry basis.

u - Analyte of interest was not detected, to the limit of detection shown.

TABLE 3
SUBSURFACE SOIL SAMPLES - SEMIVOLATILE ORGANIC COMPOUNDS
(Base/Neutral/Acid Fractions of Semivolatile Extractables)
1985 DREDGE FILL AREA
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*	
	B-3	B-4
Phenol	44 u	43 u
Aniline	220 u	220 u
Bis(2-Chloroethyl)Ether	44 u	43 u
2-Chlorophenol	44 u	43 u
1,3-Dichlorobenzene	44 u	43 u
1,4-Dichlorobenzene	44 u	43 u
Benzyl Alcohol	44 u	43 u
1,2-Dichlorobenzene	44 u	43 u
2-Methylphenol	44 u	43 u
Bis(2-Chloroisopropyl)Ether	44 u	43 u
4-Methylphenol	44 u	43 u
N-Nitroso-Di-n-Propylamine	44 u	43 u
Hexachloroethane	89 u	87 u
Nitrobenzene	44 u	43 u
Isophorone	44 u	43 u
2-Nitrophenol	89 u	87 u
2,4-Dimethylphenol	44 u	43 u
Benzoic Acid	1100 u	1100 u
Bis(2-Chloroethoxy)Methane	44 u	43 u
2,4-Dichlorophenol	89 u	87 u
1,2,4-Trichlorobenzene	44 u	43 u
Naphthalene	89 u	87 u
4-Chloroaniline	44 u	43 u
Hexachlorbutadiene	44 u	43 u
4-Chloro-3-Methylphenol	89 u	87 u
2-Methylnaphthalene	44 u	43 u
Hexachlorocyclopentadiene	89 u	87 u

* Parts per billion (ug/kg), dry basis.

u - Analyte of interest was not detected, to the limit of detection shown.

TABLE 3 (Continued)
 SUBSURFACE SOIL SAMPLES - SEMIVOLATILE ORGANIC COMPOUNDS
 (Base/Neutral/Acid Fractions of Semivolatile Extractables)
 1985 DREDGE FILL AREA
 SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*	
	B-3	B-4
2,4,6-Trichlorophenol	89 u	87 u
2,4,5-Trichlorophenol	89 u	87 u
2-Chloronaphthalene	44 u	43 u
2-Nitroaniline	89 u	87 u
Dimethyl Phthalate	44 u	43 u
Acenaphthylene	44 u	43 u
2,6-Dinitrotoluene	89 u	87 u
3-Nitroaniline	220 u	220 u
Acenaphthene	44 u	43 u
2,4-Dinitrophenol	440 u	430 u
4-Nitrophenol	440 u	430 u
Dibenzofuran	44 u	43 u
2,4-Dinitrotoluene	89 u	87 u
Diethyl Phthalate	44 u	43 u
4-Chlorophenyl-Phenylether	44 u	43 u
Fluorene	44 u	43 u
4-Nitroaniline	89 u	87 u
4,6-Dinitro-2-Methylphenol	440 u	430 u
N-Nitrosodiphenylamine	44 u	43 u
1,2-Diphenylhydrazine	89 u	87 u
4-Bromophenyl-Phenylether	89 u	87 u
Hexachlorobenzene	44 u	43 u
Pentachlorophenol	440 u	430 u
Phenanthrene	53	43 u
Anthracene	44 u	43 u
Di-n-Butyl Phthalate	44 u	43 u

*Parts per billion (ug/kg), dry basis.

u - Analyte of interest was not detected, to the limit of detection shown.

TABLE 3 (Continued)
 SUBSURFACE SOIL SAMPLES - SEMIVOLATILE ORGANIC COMPOUNDS
 (Base/Neutral/Acid Fractions of Semivolatile Extractables)
 1985 DREDGE FILL AREA
 SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*	
	B-3	B-4
Fluoranthene	70	43 u
Pyrene	86	743 u
Benzidine	1100 u	1100 u
Butylbenzylphthalate	44 u	43 u
3,3'Dichlorobenzidine	440 u	430 u
Benzo(a)Anthracene	44 u	43 u
Chrysene	44 u	43 u
Bis(2-Ethylhexyl)Phthalate	440	380
Di-n-Octyl Phthalate	44 u	43 u
Benzo(b)Fluoranthene	89 u	87 u
Benzo(k)Fluoranthene	89 u	87 u
Benzo(a)Pyrene	250	87 u
Indeno(1,2,3-cd)Pyrene	89 u	87 u
Dibenzo(a,h)Anthracene	89 u	87 u
Benzo(g,h,i)Perylene	89 u	87 u

* Parts per billion (ug/kg), dry basis.

u - Analyte of interest was not detected, to the limit of detection shown.

TABLE 4
SURFACE SOIL SAMPLES - PESTICIDES AND PCBs
1985 DREDGE FILL AREA
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*	
	B-3	B-4
alpha-BHC	11.0 u	10.0 u
beta-BHC	11.0 u	10.0 u
delta-BHC	11.0 u	10.0 u
gamma-BHC (lindane)	11.0 u	10.0 u
Heptachlor	11.0 u	10.0 u
Aldrin	11.0 u	10.0 u
Heptachlor epoxide	11.0 u	10.0 u
Endosulfan I	11.0 u	10.0 u
Dieldrin	21.0 u	21.0 u
4,4'-DDE	21.0 u	21.0 u
Endrin	21.0 u	21.0 u
Endosulfan II	21.0 u	21.0 u
4,4'-DDD	21.0 u	21.0 u
Endosulfan sulfate	21.0 u	21.0 u
4,4'-DDT	21.0 u	21.0 u
Methoxychlor	110.0 u	100.0 u
Endrin ketone	21.0 u	21.0 u
alpha-Chlordane	110.0 u	100.0 u
gamma-Chlordane	110.0 u	100.0 u
Toxaphene	210.0 u	210.0 u
Arochlor-1016	110.0 u	100.0 u
Arochlor-1221	110.0 u	100.0 u
Arochlor-1232	110.0 u	100.0 u
Arochlor-1242	110.0 u	100.0 u
Arochlor-1248	110.0 u	100.0 u
Arochlor-1254	210.0 u	210.0 u
Arochlor-1260	210.0 uu	210.0 u

*Parts per billion (ug/kg), dry basis.

u - Analyte of interest was not detected, to the limit of detection shown.

TABLE 5
GROUNDWATER SAMPLES - VOLATILE ORGANIC COMPOUNDS
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*		
	MW-1	MW-2	MW-3
Chloromethane	1 u	1 u	1 u
Bromomethane	1 u	1 u	1 u
Vinyl Chloride	1 u	1 u	1 u
Chloroethane	3 u	3 u	3 u
Methylene Chloride	1 u	1 u	1 u
Acetone	8	5 u	5 u
Carbon Disulfide	1 u	1 u	1 u
1,1-Dichloroethene	1 u	1 u	1 u
1,1-Dichloroethane	1 u	1 u	1 u
Trans-1,2-Dichloroethene	1 u	1 u	1 u
Cis-1,2-Dichloroethene	1 u	1 u	1 u
Total 1,2-Dichloroethene	1 u	1 u	1 u
Chloroform	1 u	1 u	1 u
2-Butanone	3 u	3 u	3 u
1,2-Dichloroethane	1 u	1 u	1 u
1,1,1-Trichloroethane	1 u	1 u	1 u
Carbon Tetrachloride	1 u	1 u	1 u
Vinyl Acetate	1 u	1 u	1 u
Bromodichloromethane	1 u	1 u	1 u
1,2-Dichloropropane	1 u	1 u	1 u
Trichloroethene	1 u	1 u	1 u
Benzene	1 u	1 u	1 u
Dibromochloromethane	3 u	3 u	3 u
1,1,2-Trichloroethane	1 u	1 u	1 u
Bromoform	1 u	1 u	1 u
4-Methyl-2-Pentanone	3 u	3 u	3 u
2-Hexanone	3 u	3 u	3 u
1,1,2,2-Tetrachloroethane	3 u	3 u	3 u
Tetrachloroethene	1 u	1 u	1 u
Toluene	1 u	1 u	1 u
Chlorobenzene	3 u	3 u	3 u
Trans-1,3-Dichloropropene	3 u	3 u	3 u
Ethylbenzene	1 u	1 u	1 u
Cis-1,3-Dichloropropene	3 u	3 u	3 u
Stryrene	1 u	1 u	1 u
Total Xylene	1 u	1 u	1 u

* Results in ug/L

u - indicates the analyte of interest was not detected, to the limit of detection shown.

TABLE 6
GROUNDWATER SAMPLES - CONVENTIONAL PARAMETERS
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*		
	MW-1	MW-2	MW-3
Chloride	150.0	1400.0	19.0
Iron	4.8	30.0	6.0
Managanese	0.30	3.8	0.23
Sodium	440.0	1300.0	210.0
Sulfate as SO ₄	43.0	3.0	15.0
Total Alkalinity as CaCO ₃	690.0	1100.0	310.0

* Results in mg/L

TABLE 7
SURFACE SOIL SAMPLES - PESTICIDES AND PCBs
SUBSTATION FENCE LINE AREA
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*				
	SS-1	SS-2	SS-3	SS-4	SS-5
alpha-BHC	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
beta-BHC	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
delta-BHC	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
gamma-BHC (lindane)	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
Heptachlor	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
Aldrin	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
Heptachlor epoxide	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
Endosulfan I	8.7 u	8.7 u	8.8 u	8.6 u	8.6 u
Dieldrin	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
4,4'-DDE	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
Endrin	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
Endosulfan II	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
4,4'-DDD	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
Endosulfan sulfate	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
4,4'-DDT	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
Methoxychlor	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Endrin ketone	17.0 u	17.0 u	18.0 u	17.0 u	17.0 u
alpha-Chlordane	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
gamma-Chlordane	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Toxaphene	170.0 u	170.0 u	180.0 u	170.0 u	170.0 u
Arochlor-1016	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Arochlor-1221	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Arochlor-1232	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Arochlor-1242	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Arochlor-1248	87.0 u	87.0 u	88.0 u	86.0 u	86.0 u
Arochlor-1254	170.0 u	170.0 u	180.0 u	170.0 u	170.0 u
Arochlor-1260	170.0 u	170.0 u	180.0 u	170.0 u	170.0 u

* Parts per billion (ug/kg), dry basis.

u - Analyte of interest was not detected, to the limit of detection shown.

TABLE 8
SURFACE SOIL SAMPLES - CHLORINATED HERBICIDES
SUBSTATION FENCE LINE AREA
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Sample*				
	SS-1	SS-2	SS-3	SS-4	SS-5
2,4-D	11.0 u	11.0 u	11.0 u	11.0 u	11.0 u
2,4,5-T	5.4 u	5.5 u	5.5 u	5.5 u	5.4 u
2,4,5-TP	5.4 u	5.5 u	5.5 u	5.5 u	5.4 u

* Parts per billion (ug/kg), dry basis.

u - indicates the analyte of interest was not detected,
to the limit of detection shown.

ABL
SUMMARY OF ANALYTES DETECTED
SEATTLE CITY LIGHT LEASE OPTION

Analyte	Units	Soil												Water		
		MW-1	MW-2	MW-3	B-1	B-2	B-3	B-4	SS-1	SS-2	SS-3	SS-4	SS-5	MW-1	MW-2	MW-3
Volatile Organic Compounds																
Acetone	ug/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8	5u	5u
Semivolatile Compounds																
Fluoranthene	ug/kg	39u	43u	45u	43u	41u	70	43u	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	ug/kg	39u	43u	45u	43u	41u	53	43u	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	ug/kg	87	160	340	390	490	440	380	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	ug/kg	39u	43u	74	43u	41u	86	43u	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	ug/kg	96	86u	340	140	83u	250	87u	NA	NA	NA	NA	NA	NA	NA	NA
Metals																
Arsenic	mg/kg	4.9	4.2	7.5	5.9	4.8	8.7	5.6	NA	NA	NA	NA	NA	NA	NA	NA
Barium	mg/kg	50	76	67	56	42	74	50	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	mg/kg	1.0	1.3	1.3	0.9	0.5u	1.2	0.6	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	mg/kg	15	17	20	13	12	18	13	NA	NA	NA	NA	NA	NA	NA	NA
Copper	mg/kg	20	36	36	19	17	33	20	NA	NA	NA	NA	NA	NA	NA	NA
Lead	mg/kg	7.3	15	16	8.7	8.2	17	7.4	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	mg/kg	0.1u	0.1u	0.24	0.1u	0.1u	0.51	0.1u	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	mg/kg	0.5u	0.5u	0.8	0.5	0.5u	0.5	0.5u	NA	NA	NA	NA	NA	NA	NA	NA
Conventional Paramenters																
Chloride	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	150	1400	150
Sulfate	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	43	3	150
Alkalinity	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	690	1100	310
Iron	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.8	30	60
Manganese	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.30	3.8	0.2
Sodium	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	440	1300	210

NA - Sample not analyzed for this analyte

u - Compound was not detected; associated value is the sample detection limit.

All of the conventional water quality parameters were detected at low to moderate concentrations. Chloride concentrations were highest at Well MW-2 (1400 mg/l) indicating brackish conditions in the native sand aquifer at that location and some influence from the saltwater wedge in the adjacent Duwamish Waterway. Iron, manganese, sodium, and total alkalinity are also highest at Well MW-2. Field measurements indicate the groundwater has a pH of 7.0 to 7.1.

3.4 SCL Substation Fence Line Area

The five surface soil samples collected along the SCL substation fence line were analyzed for pesticides, PCBs, and three chlorinated herbicides. The five samples did not contain detectable concentrations of any of these compounds at detection limits of 8.6 to 180 ug/kg for pesticides, 86 to 170 ug/kg for PCBs, and 5.4 to 11.0 ug/kg for herbicides.

4.0 DISCUSSION

4.1 1968 Dredge Fill Area

The 1968 dredge fill contained low concentrations of PAHs and metals. Total PAHs concentrations (140 to 414 ug/kg) in composite samples from the fill were below the draft soil clean-up levels for total carcinogenic PAHs specified in the Washington State Model Toxics Control Act (MTCA) Cleanup Regulations (1.0 mg/kg) (9 March 1990). These PAH concentrations are probably representative of background PAH concentrations of dredge fill in the Duwamish industrial area.

Total metals concentrations in the 1968 fill samples are well below draft MTCA soil clean-up levels and are at concentrations so low they will not fail EP toxicity criteria.

4.2 1985 Dredge Fill Area

The 1985 dredge fill also contained low concentrations of PAHs and metals. PCBs were not detected in either composite fill sample at detection limits that are well below the most stringent PCB clean-up standards. Several PAHs were detected in the composite soil sample from Boring B-3 at a total concentration of 549 ug/kg. Again, this concentration is below the draft MTCA clean-up standard for PAHs in soil.

Total metals concentrations in the 1985 fill samples were well below MTCA clean-up levels. Although the concentration of mercury (0.51 mg/kg) in the composite sample from Boring B-3 is slightly elevated above the typical range for natural

soils, it is still below the draft MTCA clean-up level for mercury in soil (1.0 mg/kg).

4.3 Groundwater

No volatile organic compounds were detected in groundwater at the site, except acetone, at a very low concentration (8 ug/l) in the sample from Well MW-1. Acetone is a common laboratory contaminant and its presence in sample MW-1 may be a laboratory artifact, although it was not found in the associated laboratory blank.

Chloride, iron, and manganese concentrations (1,400 mg/L, 30 mg/L, 3.8 mg/L, respectively) at Well MW-2 exceed Washington secondary maximum contaminant levels (SMCLS) for these constituents (SMCLS: chloride = 250 mg/l; iron = 0.3 mg/l; manganese = 0.05 mg/l). The SMCLS for iron and manganese are also exceeded by samples from Wells MW-1 and MW-3.

4.4 SCL Substation Fence Line Area

PCBs, pesticides, and herbicides were not detected in composite surface soil samples collected from beneath decorative gravel along the substation fence line. The detection limits reported for these compounds are well below their respective regulatory clean-up levels. The fresh appearance of the decorative gravel along the fence line and the uniform nature of the sandy soil beneath suggests that they have been placed within the last few years.

5.0 RECOMMENDATIONS

Based on the results of the baseline soil and groundwater quality assessment, no further sampling at the SCL long-term lease option property is recommended.

Boeing should maintain a copy of this baseline report in appropriate files so that it is available for reference at the time of the lease termination.

Because 2-inch-diameter PVC monitoring wells are not anticipated to remain functional for the entire 50-year term of the lease, and because the risk of well damage during building construction is relatively high even with traffic protection posts in place, the three monitoring wells installed on the property should be abandoned in accordance with Chapter 173-160 of the Washington Administrative Code prior to the initiation of construction activities.

If the monitoring wells are left in place, any further groundwater sampling or well redevelopment should be conducted by qualified personnel.

APPENDIX C

PSDDA PARAMETERS AND METHODS

Parameter	Prep Method	Analysis Method	SL	PSDDA BT	ML	SMS SQS	July 96 draft SMS detection limits (1)	1988 LAET
CONVENTIONALS:								
Total Solids (%)	---	Pg.17 (2)	---	---	---	---	---	---
Total Volatile Solids(%)	---	Pg.20 (2)	---	---	---	---	---	---
Total Organic Carbon (%)	---	DOE (3)	---	---	---	---	---	---
Grain Size	---	Modified ASTM with Hydrometer	---	---	---	---	---	---
METALS								
			units: mg/kg dw (4)			units: mg/kg dw	units: mg/kg dw	
Antimony	3050 (5)	GFAA (6)	20	146	200	---	---	150
Arsenic	3050	GFAA	57	507.1	700	57	19	57
Cadmium	3050	GFAA	0.96	---	9.6	5.1	1.7	5.1
Chromium	3050	GFAA	---	---	---	260	87	260
Copper	3050	ICP (7)	81	---	810	390	130	390
Lead	3050	ICP	66	---	660	450	150	450
Mercury	7471 (8)	7471	0.21	1.5	2.1	0.41	0.14	0.59
Nickel	3050	ICP	140	1022	---	---	---	>140
Silver	3050	GFAA	1.2	4.6	6.1	6.1	2.0	>0.56
Zinc	3050	ICP	160	---	1600	410	137	410
ORGANICS								
LPAH								
			units: ug/kg dw			units: mg/kg oc	units: ug/kg dw	
Naphthalene	3550 (9)	8270 (10)	210	---	2100	99	700	2100
Acenaphthylene	3550	8270	64	---	640	66	433	>560
Acenaphthene	3550	8270	63	---	630	16	167	500
Fluorene	3550	8270	64	---	640	23	180	540
Phenanthrene	3550	8270	320	---	3200	100	500	1500
Anthracene	3550	8270	130	---	1300	220	320	960
2-Methylnaphthalene	3550	8270	67	---	670	38	223	670
Total LPAH			610	---	6100	370	---	5200
HPAH								
			units: ug/kg dw			units: mg/kg oc	units: ug/kg dw	
Fluoranthene	3550	8270	630	4600	6300	160	567	1700
Pyrene	3550	8270	430	---	7300	1000	867	2600
Benzo(a)anthracene	3550	8270	450	---	4500	110	433	1300
Chrysene	3550	8270	670	---	6700	110	467	1400
Benzo(a)fluoranthene	3550	8270	800	---	8000	230	1067	3200
Benzo(a)pyrene	3550	8270	680	4964	6800	99	533	1600
Indeno(1,2,3-c,d)pyrene	3550	8270	69	---	5200	34	200	600
Dibenzo(a,h)anthracene	3550	8270	120	---	1200	12	77	230
Benzo(g,h,i)perylene	3550	8270	540	---	5400	31	223	670
Total HPAH			1800	---	51000	960	---	12000
CHLORINATED HYDROCARBONS								
			units: ug/kg dw			units: mg/kg oc	units: ug/kg dw	
1,3-Dichlorobenzene	P&T (11)	8260 (11)	170	1241	---	---	---	>170

Parameter	Prep Method	Analysis Method	SL	PSDDA BT	ML	SMS SQS	July 96 draft SMS detection limits (1)	1988 LAET
1,4-Dichlorobenzene	P&T	8260	26	190	260	3.1	37	110
1,2-Dichlorobenzene	P&T	8260	19	37	350	2.3	35	35
1,2,4-Trichlorobenzene	3550	8270	13	---	64	0.81	31	31
Hexachlorobenzene (HCB)	3550	8270	23	168	230	0.38	22	22
PHTHALATES			units: ug/kg dw			units: mg/kg oc	units: ug/kg dw	
Dimethyl phthalate	3550	8270	160	1168	---	53	24	71
Diethyl phthalate	3550	8270	97	---	---	61	67	>48
Di-n-butyl phthalate	3550	8270	1400	10220	---	220	467	1400
Butyl benzyl phthalate	3550	8270	470	---	---	4.9	21	63
Bis(2-ethylhexyl)phthalate	3550	8270	3100	13870	---	47	433	1300
Di-n-octyl phthalate	3550	8270	6200	---	---	58	2067	>420
PHENOLS			units: ug/kg dw			units: ug/kg dw	units: ug/kg dw	
Phenol	3550	8270	120	876	1200	420	140	420
2 Methylphenol	3550	8270	20	---	72	63	63	63
4 Methylphenol	3550	8270	120	---	1200	670	223	670
2,4-Dimethylphenol	3550	8270	29	---	50	29	29	29
Pentachlorophenol	3550	8270	100	504	690	360	120	>140
MISCELLANEOUS EXTRACTABLES			units: ug/kg dw			units: ug/kg dw	units: ug/kg dw	
Benzyl alcohol	3550	8270	25	---	73	57	57	57
Benzoic acid	3550	8270	400	---	690	650	217	650
			units: ug/kg dw			units: mg/kg oc	units: ug/kg dw	
Dibenzofuran	3550	8270	54	---	540	15	180	540
Hexachloroethane	3550	8270	1400	10220	14000	---	---	---
Hexachlorobutadiene	3550	8270	29	212	290	3.9	11	11
N-Nitrosodiphenylamine	3550	8270	28	161	220	11	28	28
VOLATILE ORGANICS			units: ug/kg dw				units: ug/kg dw	
Trichloroethene	P&T	P&T	160	1168	1600	---	---	---
Tetrachloroethene	P&T	P&T	14	102	210	---	---	57
Ethylbenzene	P&T	P&T	10	27	50	---	---	10
Total Xylene	P&T	P&T	12	---	160	---	---	40
PESTICIDES & PCBs			units: ug/kg dw			units: mg/kg oc	units: ug/kg dw	
Total DDT	---	---	6.9	50	69	---	---	---
p,p'-DDE	3540 (12)	8081 (12)	---	---	---	---	---	9
p,p'-DDD	3540	8081	---	---	---	---	---	16
p,p'-DDT	3540	8081	---	---	---	---	---	>6
Aldrin	3540	8081	10	37	---	---	---	---
Chlordane	3540	8081	10	37	---	---	---	---
Dieldrin	3540	8081	10	37	---	---	---	---
Heptachlor	3540	8081	10	37	---	---	---	---
Lindane	3540	8081	10	---	---	---	---	---
Total PCBs	3540	8081	130	38 (13)	2500	12	6	130

1. *Recommended Sample Preparation Methods, Cleanup Methods, Analytical Methods and Detection Limits for Sediment Management Standards*, Chapter 173-204 WAC, Draft - July 1996.
2. *Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound* , Puget Sound Estuary Program, March, 1986.
3. *Recommended Methods for Measuring TOC in Sediments* , Kathryn Bragdon-Cook, Clarification Paper, Puget Sound Dredged Disposal Analysis Annual Review, May, 1993.
4. units: ug = microgram, mg = milligram, kg = kilogram, dw = dry weight, oc = organic carbon.
5. *Test Methods for Evaluating Solid Waste. Laboratory manual physical/chemical methods* . Method 3050, SW-846, 3rd ed., Vol 1A, Chapter 3, Sec 3.2, Rev 1. Office of Solid Waste and Emergency Response, Washington, DC.
6. Graphite Furnace Atomic Absorption (GFAA) Spectrometry - SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* , EPA 1986.
7. Inductively Coupled Plasma (ICP) Emission Spectrometry - SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* , EPA 1986.
8. *Test Methods for Evaluating Solid Waste. Laboratory manual physical/chemical methods* . Method 7471, SW-846, 3rd ed., Vol 1A, Chapter 3, Sec 3.3. Office of Solid Waste and Emergency Response, Washington, DC.
9. Sonication Extraction of Sample Solids - Method 3550 (Modified), SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* , EPA 1986. Method is modified to add matrix spikes before the dehydration step rather than after the dehydration step.
10. GCMS Capillary Column - Method 8270, SW-846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* , EPA 1986.
11. Purge and Trap Extraction and GCMS Analysis - Method 8260, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* , EPA 1986.
12. Soxhlet Extraction and Method 8081, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods* , EPA 1986.
13. Total PCBs BT value in mg/kg oc.

APPENDIX D

QA2 DATA REQUIREMENTS

CHEMICAL VARIABLES

ORGANIC COMPOUNDS

The following documentation is needed for organic compounds:

- A cover letter referencing or describing the procedure used and discussing any analytical problems
- Reconstructed ion chromatograms for GC/MS analyses for each sample
- Mass spectra of detected target compounds (GC/MS) for each sample and associated library spectra
- GC/ECD and/or GC/flame ionization detection chromatograms for each sample
- Raw data quantification reports for each sample
- A calibration data summary reporting calibration range used [and decafluorotriphenylphosphine (DFTPP) and bromofluorobenzene (BFB) spectra and quantification report for GC/MS analyses]
- Final dilution volumes, sample size, wet-to-dry ratios, and instrument detection limit
- Analyte concentrations with reporting units identified (to two significant figures unless otherwise justified)
- Quantification of all analytes in method blanks (ng/sample)
- Method blanks associated with each sample
- Recovery assessments and a replicate sample summary (laboratories should report all surrogate spike recovery data for each sample; a statement of the range of recoveries should be included in reports using these data)
- Data qualification codes and their definitions.

METALS

For metals, the data report package for analyses of each sample should include the following:

- Tabulated results in units as specified for each matrix in the analytical protocols, validated and signed in original by the laboratory manager
- Any data qualifications and explanation for any variance from the analytical protocols
- Results for all of the QA/QC checks initiated by the laboratory
- Tabulation of instrument and method detection limits.

All contract laboratories are required to submit metals results that are supported by sufficient backup data and quality assurance results to enable independent QA reviewers to conclusively determine the quality of the data. The laboratories should be able to supply legible photocopies of original data sheets with sufficient information to unequivocally identify:

- Calibration results
- Calibration and preparation blanks
- Samples and dilutions
- Duplicates and spikes
- Any anomalies in instrument performance or unusual instrumental adjustments.

BIOASSAYS

Amphipod Mortality Test

The following data should be reported by all laboratories performing this bioassay:

- Daily water quality measurements during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia & sulfides at test initiation and termination)
- Daily emergence for each beaker and the 10-day mean and standard deviation for each treatment
- 10-day survival in each beaker and the mean and standard deviation for each treatment
- Interstitial salinity values of test sediments
- 96-hour LC_{50} values with reference toxicants.
- Any problems that may have influenced data quality.

Neanthes Growth Test

The following data should be reported by all laboratories performing this bioassay:

- Water quality measurements at test initiation and termination and every three days during testing (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia & sulfides at test initiation and termination)
- 20-day survival in each beaker and the mean and standard deviation for each treatment.
- Initial biomass
- Final biomass (20-day) for test, reference and control treatments.
- 96-hour LC_{50} values with reference toxicants.
- Any problems that may have influenced data quality.

Sediment Larval Test

The following data should be reported by all laboratories performing this bioassay:

- Daily water quality measurements (e.g., dissolved oxygen, temperature, salinity, pH) (plus ammonia + sulfides at test initiation & termination)
- Individual replicate and mean and standard deviation data for larval survival at test termination.
- Individual replicate and mean and standard deviation data for larval abnormalities at test termination
- 48-hour LC_{50} and EC_{50} values with reference toxicants.
- Any problems that may have influenced data quality.

APPENDIX E

RAW DATA REQUIREMENTS FOR DAIS

DAIS DATA CHECKLIST

Sample Locations and Compositing				
	Test Sediment	Reference Sediment	Control Sediment	Seawater Control
Latitude and Longitude (to nearest 0.1 second)				
NAD 1927 or 1983				
USGS Benchmark ID				
Station name (e.g. Carr Inlet)				
Water depth (corrected to MLLW)				
Drawing showing sampling locations and ID numbers				
Compositing scheme (sampling locations/depths for composites)				
Sampling method				
Sampling dates				
Estimated volume of dredged material represented by each DMMU				
Positioning method				
Sediment Conventional				
Preparation and analysis methods				
Sediment conventional data and QA/QC qualifiers				
QA qualifier code definitions				
Triplicate data for each sediment conventional for each batch				
Units (dry weight except total solids)				
Method blank data (sulfides, ammonia, TOC)				
Method blank units (dry weight)				
Analysis dates (sediment conventionals, blanks, TOC CRM)				
TOC CRM ID				
TOC CRM analysis data				
TOC CRM target values				
Grain Size Analysis				
Fine grain analysis method				
Analysis dates				
Triplicate for each batch				
Grain size data (complete sieve and phi size distribution)				

Chemicals of Concern Analysis Data				
	Metals	Semivol.	Pest./PCBs	Volatiles
Extraction/digestion method				
Extraction/digestion dates (test sediment, blanks, matrix spike, reference material)				
Analysis method				
data and QA qualifier included for:				
test sediments				
reference materials including 95% confidence interval (each batch)				
method blanks (each batch)				
matrix spikes (each batch)				
matrix spike added (dry weight basis)				
replicates (each batch)				
Units (dry weight)				
Method blank units (dry weight)				
QA/QC qualifier definitions				
Surrogate recovery for test sediment, blank, matrix spike, ref. material				
Analysis dates (test sediment, blanks, matrix spike, reference material)				



Shaded areas indicate required data

BIOASSAYS

Amphipod Mortality and Emergence				
	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Species Name				
Mortality and Emergence:				
Start date				
Daily emergence (for 10 days)				
Survival at end of test				
Number failing to rebury at end of test				
Positive Control:				
Toxicant used				
Toxicant concentrations				
Exposure time				
LC50				
LC50 method of calculation				
Start date				
Survival data				
Water Quality Measurement Methods:				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				
Water salinity				
Water Quality:				
Temperature (day 0 through day 10)				
pH (day 0 through day 10)				
Dissolved oxygen (day 0 through day 10)				
Water salinity (day 0 through day 10)				
Sulfide (day 0, day 10)				
Ammonia (day 0, day 10)				
Interstitial water salinity (day 0)				

Neanthes 20-day Growth Test				
	Each Batch	Test Sediment	Reference Sediment	Control Sediment
Starting age (in days post-emergence)				
Food type				
Quantity (mg/beaker/interval)				
Feeding interval (hours)				
Biomass and Mortality:				
Start date				
Initial counts and weights (mg dry weight)				
Number of survivors and final weights (mg dry weight)				
Positive Control:				
Toxicant used				
Toxicant concentration				
Exposure time				
LC50				
LC50 method of calculation				
Start date				
Survival data				
Water Quality Measurement Methods				
Dissolved oxygen				
Ammonia				
Interstitial salinity				
Sulfide				
Water salinity				
Water Quality:				
Temperature (days 0, 3, 6, 9, 12, 15, 18, 20)				
pH (days 0, 3, 6, 9, 12, 15, 18, 20)				
Dissolved oxygen (days 0, 3, 6, 9, 12, 15, 18, 20)				
Water salinity (days 0, 3, 6, 9, 12, 15, 18, 20)				
Interstitial salinity (day 0)				
Sulfide (initial and final)				
Ammonia (initial and final)				

Sediment Larval Mortality and Abnormality				
	Each Batch	Test Sediment	Reference Sediment	Seawater Control
Species Name				
Bioassay Parameters				
Inoculation time (hours)				
Exposure time (hours)				
Stocking beaker density (#/ml)				
Stocking aliquot size (ml)				
Aeration (yes/no)				
Mortality and Abnormality:				
Start date				
Initial count (minimum of five 10-ml aliquots)				
Final Count:				
Aliquot size (ml)				
Number normal per aliquot				
Number abnormal per aliquot				
Water Quality Measurement Methods:				
Dissolved oxygen				
Ammonia				
Sulfide				
Water salinity				
Water Quality:				
Temperature (daily)				
pH (daily)				
Dissolved oxygen (daily)				
Water salinity (daily)				
Sulfide (initial and final)				
Ammonia (initial and final)				
Positive Control:				
Toxicant used				
Toxicant concentrations				
Exposure time				
EC50				
EC50 method of calculation				
Start date				
Normal/abnormal counts				